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Raising the "F-4"

By J. F. Springer

THE American submarine "F-4," which now lies at the bottom of the sea in Honolulu Harbor, has presented to the Navy Department a very serious problem. The actual raising of the boat, lying as she does in 40 or 50 fathoms of water, has proved a task to which local equipment and skill are unequal. The unsurmounted difficulty is concerned largely with the necessity of properly securing to the body of the vessel the chains or cables by which she is to be hoisted to the surface.

Accordingly, interest focuses upon the problem of making fast the hoisting lines. But divers capable of successfully performing the duties are very few. Some years ago Angel Erostarbe, presumably a Spaniard, went down in 182 feet of water near Cape Finisterre, at the northwestern corner of Spain, and successfully recovered some $45,000 worth of silver bars from a wrecked steamer. James Hooper went down to the depth of 204 feet near Pichidanque, South America. But these depths, great though they are, are still far short of the necessities at Honolulu.

However, the U. S. Navy has in it a number of men who have been developing the possibilities of deep diving. One of these, Chief Gunner's Mate S. J. Drellishak, has been down to a depth of 274 feet in the waters of Long Island Sound. Others have done work comparable with this. A group of these men under Gunner G. D. Stillson has been dispatched from New York for Honolulu by the Navy Department. Their duty upon arrival will be, first of all, to attach to the "F-4" the necessary lines.

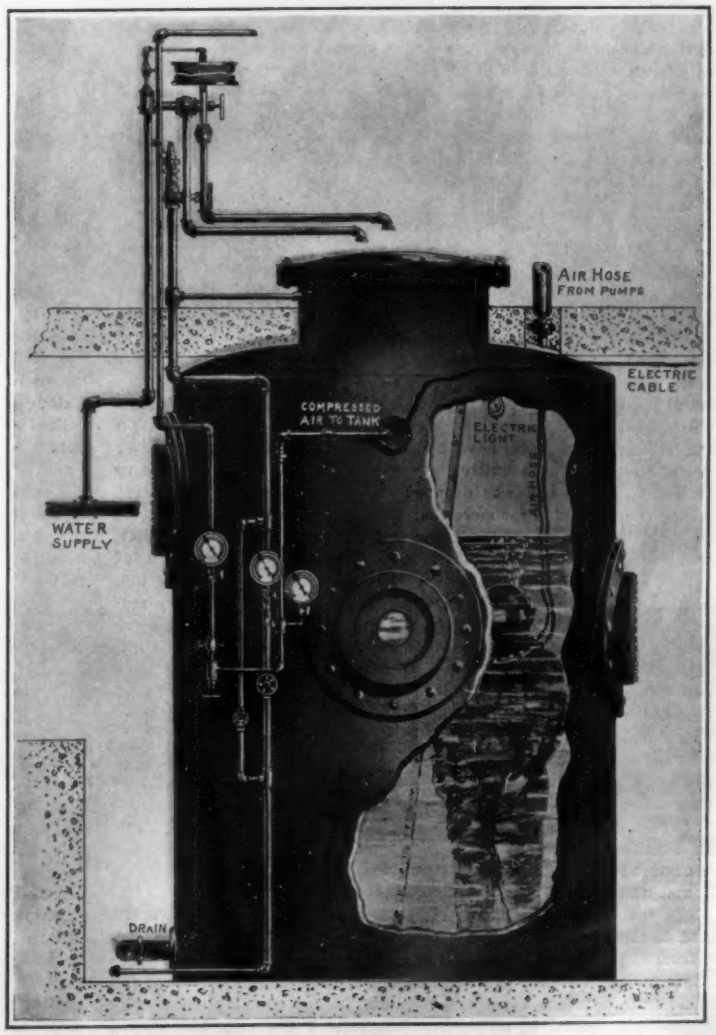
Deep diving is difficult because of the enormous pressure of the water. The pressure of the water increases at the rate of about 0.43½ pound per square inch for every vertical foot. At 200 feet below the surface the water surrounding a diver's body exerts the very great pressure of 87 pounds per square inch. Assuming a man's body to have a superficial area of 2,160 square inches, he would accordingly at this depth be subjected to a total pressure of nearly 94 short tons. At 300 feet the pressure would be 130½ pounds per square inch and 141 tons for the whole body.

Upon consideration, however, this matter seems less frightful than it does at first sight. We are familiar with the pressure of 15 pounds per square inch which we all have to endure as we live and move around on the surface. This amounts to 16 tons for the entire body. We suffer no discomfort because the external pressure is everywhere balanced by an equal internal one. The flesh of the body contains air and liquids which are also exerting a pressure of 15 pounds per square inch; so that every conceivable solid particle has in every direction two balancing pressures. The effect is to put the particle under no stress whatever relatively to other particles. One particle of the body is forced neither toward nor away from any other particle.

This equilibrium may be maintained as the external pressure is increased, thus making possible deep water diving. The depth of 274 feet has been actually accomplished with but little or no discomfort.

It is necessary, as greater and greater depths are attained by a descending diver, that pressure conditions within the body

Ready to descend.



The tank at the Brooklyn Navy Yard in which the Government divers who will assist in raising the sunken submarine received their training.

be continually increased to match the increasing external pressures. In practice, it is found that this takes place very rapidly, if the pressure of the air supplied by the diver is progressively added to at the rate of increase of the external hydrostatic pressure. That is to say, a diver may go *down* rapidly if the air pressure is kept right. Apparently, the body automatically responds and permits a rapid *increase* of internal pressures without especial discomfort. Upon ascending, however, all this is changed. A diver may make a quick descent to a considerable depth, but he may not safely make the return trip quickly. There must be stops of considerable length to permit the body to accommodate itself to the reduced internal pressure. Recent practice seems, however, to favor making the first half of the ascent a single, fairly rapid operation. The remainder of the distance is then divided into sections, with the rests at the ends of sections rather long. Altogether, to come up from 250 or 300 feet may require from one to two hours.

With the modern diving equipment, the diver is in constant telephonic or other communication with those at the surface. His personal feeling that all is well is relied on largely in letting him down and hoisting him up. The diving suit enables him to live in an atmosphere of air. The tension of this air is kept continually equal to the hydrostatic pressure without. Consequently, he has a means of knowing the relative pressure conditions other than the physiological sensations of his body. If he notices a distension of his suit, he knows this means that the air pressure is too great. Or, if he notices that it is pressed in upon him, he knows that this signifies too low a pressure of air.

In supplying the diver with air, provision must be made for two distinct things. First, the requisite pressure must be maintained—this despite the fact that air is being continually discharged from a valve in the diving helmet. This brings us to the second requirement. The air surrounding the diver's head must be kept fresh. He keeps breathing, absorbing oxygen and emitting carbon dioxide. If there were no outlet, the atmosphere about him would soon consist of but little else than carbon dioxide and nitrogen, when he would "drown," though still in the dry. Consequently, in addition to the maintenance of the pressure, it is necessary to provide for a continuous renewal of air.

In order to meet these requirements, the air pump must be operated more and more vigorously as the diver goes to lower and lower depths, or more and more powerful methods must be employed. This may be illustrated by the fact that with one type of standard hand-operated air pumps, a single cylinder will supply a diver with sufficient air in cases where the pressure does not exceed 21 pounds per square inch. Where the pressure is greater than this, but less than 42 pounds, two cylinders are required. For pressure running up to 78 pounds, four cylinders are necessary; and six cylinders from this pressure up to, say, 90 pounds. At Honolulu, the pressure required may run up to 125 pounds or more, and will probably be supplied by a power-operated air compressor.

The diver has to be alert as to whether the proper pressure is being maintained and also as to whether the air is supplying him with enough oxygen. This lat-

(Concluded on page 367.)

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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp* the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

The purpose of this journal is to record accurately, simply, and interestingly, the world's progress in scientific knowledge and industrial achievement.

Are Obsolete Battleships Obsolete?

MANY and varied are the lessons of the war, and generally speaking, the operations both on sea and land, it must be admitted, have verified the theories upon which the vast armaments of the past quarter of a century have been developed.

There are some exceptions to be noted, and among these we draw attention to the extensive use which has been made of battleships which were supposed to be obsolete and therefore unsuited to the severe tasks which modern naval warfare imposes. It has been urged, and pretty generally agreed, that when a battleship is ten years old it is becoming obsolete, and that when it is twenty years old it is entirely so, and should be stricken from the active list. This estimate has been based upon the premise that the duty of the battleship, first and last, lies in the line where it may give and take the heaviest blows of a great fleet action. The rapidity with which the military value of the battleship decreases is in the direct ratio of the rapidity with which the punishing power of the gun, the torpedo, and the mine increases. And so it has come about that we have battleships of the first line, second line and the reserve, from the last-named of which the aged ship is relegated to the scrap heap, the useful age of the battleship having been arbitrarily placed at one-score years and nothing.

Now, certain events in the naval operations of the war suggest that the period of time which elapses between the final haul down of the flag and the sale of the obsolete ship should be extended. We refer to the useful work which has been done by some of the old battleships in operations of a kind which were never contemplated by the admiralties when the present war opened. Thus, it has been well established that it was certain old British battleships which assisted so materially the work of the Belgium army in holding back the German drive for Calais, the heavy shell fire of the large-caliber guns being used with deadly effect in enfilading the German entrenchments and wrecking the gun positions.

An even more notable instance of the use of early ships was seen in the recent operations in the Dardanelles. For it is a fact that, with the exception of the "Queen Elizabeth" and the battle-cruiser "Inflexible," the operations in the Ægean Sea, formidable as they were, were carried out without calling upon any of the ships of the British North Sea fleet under Jellicoe, or the fleet of modern French battleships which is holding the Austrians secure at the northern end of the Adriatic. In the Ægean squadron are to be found such ships as the "Majestic" and "Prince George," which were laid down twenty-one years ago—ships which had come to be regarded in the British navy as not worth the cost of their upkeep. In the French navy, also, in the Ægean are to be found such armored vessels as the "Requin," dating from 1885, and the "Jaureguiberry," from the year 1895.

Some of these ships, it is true, have been sent to the bottom; but if, as is stated in the dispatches from the allied commanders, their loss was due to contact with mines, it can be said that, in view of the terrific rending power of these machines, probably the more modern battleships would also have succumbed to the attack.

And this brings to our mind the fact that the old battleships with their heavy armor and powerful guns might be used to good advantage by sinking them down to a bed of grillage, carried on piling driven into some of the shoals at the entrances to our harbors. Weighted with concrete, heavily rip-rapped, and periodically given a heavy coat of paint, these ships would provide a speedy and highly economical means of covering adjoining channels with the fire of heavy armor-piercing guns. This suggestion was illustrated and fully described in an article by a retired naval officer which appeared in these columns a few years ago. The arguments advanced then hold good to-day. We believe there is sufficient merit in the proposal to warrant its careful investigation by the Ordnance and Engineers' Corps of our Army.

Credit for the Gatun Dam

"THERE is glory enough to go around," said one of the ranking officers engaged in the sea fight of Santiago when the question of credit for the American victory was under discussion; and the same truth applies to that great victory over the forces of nature which has been won by American brains and resources in the completion of the Canal at Panama.

In the distribution of credit (and that history will make such an allotment is certain) we wish to draw attention to the fact that, so far as the American share in the enterprise is concerned, the credit for first pointing out the advantages in the way of construction and operation afforded by building a big dam at Gatun were first formally advocated by an American engineer, Mr. C. D. Ward, a member of the American Society of Civil Engineers.

The advantages of constructing a dam at Gatun were first pointed out by M. Godin Lepinay before de Lesseps' Paris Congress in 1879. In 1880 Mr. Ashbel Welch suggested the advantages of Gatun to the American Society of Civil Engineers, and he then acknowledged that he was indebted for the idea to Mr. Ward. Neither of these engineers had at that time heard of Lepinay's plan. The suggestion had never been followed up and was soon dropped, either as being impracticable or as being supplanted by the more practicable project for a dam at Bohio.

It will be remembered that the present scheme as carried out was adopted as the result of the minority report of the Consulting Board of Engineers in 1905. Subsequently four members of the Consulting Board gave it as their opinion that the revival of the dead and forgotten plan was due to a paper read before the meeting of the American Society of Civil Engineers in 1904 by Mr. Ward. The late A. Noble in a letter dated April 18th, 1907, speaking of that paper, said: "The Ward paper created so deep an impression among engineers that one of the earlier examinations made by the First Construction Commission appointed by President Roosevelt was to determine by means of boring the depth to rock and the nature of the overlying earth along the line of the proposed dam. The earth was found to extend to such a depth that the construction of a masonry dam was found to be impracticable and the project for a dam of this kind was too hastily set aside. There were many, however, who believed with Mr. Ward, that a perfectly safe and satisfactory dam could be made of earth, and that the advantages of the location from the point of view of navigation were so obvious, that the subject was not allowed to drop, and it received favorable consideration from the minority of the Board of Consulting Engineers in 1905. . . .

"While it is impossible to say that the Gatun location would not have been adopted had Mr. Ward's paper not been written, the fact that the first suggestion to this end was dropped and remained unheeded, except by him, for more than twenty years, and that its revival was due to him exclusively, make it most probable that, but for his persistent efforts, the excellent plan of Canal now adopted would not have developed, and either an inferior lock plan or a far more costly sea-level plan would have been adopted."

The paper read before the Society has so much historical interest that we reproduce it in the current issue of the SUPPLEMENT.

The Storage and Handling of Gasoline

THE extensive use of inflammable liquids in the arts, especially as fuel for motors of various forms, and in particular for motor vehicles, has attracted considerable attention within the last few years to the conditions under which such inflammable liquids are stored and handled. Buildings for stabling motor vehicles are now quite as common as horse stables were but a few years ago, and the inflammable and explosive character of the gasoline presents many serious fire hazards, especially where a number of these vehicles are accommodated in a single building, and where considerable quantities of gasoline necessarily must be stored and handled. The matter has been a serious one for the insurance interests, as very few States or cities have had effective laws or ordinances on the subject of inflammable liquids, and what is even more striking, has been the wide diversity of regulations as well as of practice. Thus, in some cities inflammable liquids can only be stored outside of buildings, permitting storage tanks under the sidewalk. In others, tanks under the sidewalks have been specifically prohibited. In some places inflammable liquids may be stored in a basement. In others, basement storage of inflammable liquids is expressly forbidden. In New York city, large quantities of inflammable liquids may be stored, but no considerable amount may be kept in any single container. For example, not more than 275 gallons of gasoline can be stored in a single tank, but any number of tanks may be placed on the premises, so as to secure the supply required for the number of motor vehicles or the industry concerned.

In fact, the lack of harmony in American methods and requirements has been most extraordinary. In some few cases there may be better practice than in Germany and other European countries, but in most cities conditions are such as to give rise to exceptional hazards, and serious fires have resulted from lack of care in the handling and storage of gasoline, both in private and public garages, as well as from inflammable liquids in other establishments.

Quite recently, in connection with this handling, storage, and sale of inflammable liquids, an attempt to secure more effective regulation and general harmony has been made, and a suggested ordinance has been drawn up for general adoption. This has been approved by the National Board of Fire Underwriters, whose engineers were largely instrumental in its preparation, and by the National Fire Protection Association, as well as by such organizations as the Paint Manufacturers' Association, the National Paint, Oil, and Varnish Association, the National Varnish Makers' Association, the National Dry Cleaners' Association, and the Independent Petroleum Marketers' Association, all of these organizations, and particularly the last named, actively participating in the various discussions, and contributing materially to the rules which were drawn up.

These rules are intended to represent the best practice and are reasonably strict and severe, yet at the same time not to be unreasonably oppressive in their bearing on small dealers or on the conduct of ordinary business. The aim has been to be explicit and leave as little to the discretion of municipal authorities and fire department officials as possible, for it has been found that inefficiency and possibly worse conditions are likely to result when fire chiefs or fire commissioners can make arbitrary rules.

The proposed ordinance has been designed to serve as a model, applicable throughout the country generally, and was prepared only after a thorough consideration of the many points involved and the interests of the various parties concerned.

It not only deals with the garage and the gasoline hazard in connection with motor vehicles, but also with the subject of inflammable liquids and the products thereof in general, regulating their use and handling, storage, and sale. Such liquids are grouped in three classes according to the "flash point" or temperature at which the vapor arising from them will ignite, determined with various forms of approved testers as used by the United States Bureau of Mines and fire officials generally. Inflammable liquids on this basis are divided into three classes, and gasoline, which is the fuel of most motor vehicles, is included in Class I, embracing the most inflammable liquids, Class I being defined as liquids with flash point 27 deg. Fahr. (3 deg. Cent.), closed cup tester, which is equivalent to 30 deg. Fahr., open cup tester.

The proposed ordinance has furnished the basis of recent rules or statutes enacted or promulgated by competent authority, so that, all things considered, it may be said to summarize the best American practice and requirements. These rules should result in reducing the losses from fire due to improperly constructed and maintained garages, and should, therefore, act to offset the increased hazard due to the storage and handling of inflammable liquids in ever-increasing quantities.

Canada's Railways.—Had not the war seriously unsettled industry and trade throughout Canada, the Dominion would have developed in 1915 a trunk-line railway mileage of approximately 40,000 miles, including, of course, all subsidiary or contracted lines and lines running through American territory. This would have placed the country second to no other in the world in railway standing. The completion of the Grand Trunk-Pacific system has been retarded. The line extending westward from Winnipeg to the Pacific terminus at Prince Rupert, B. C., has been in operation for some months, but the line from Winnipeg to Moncton, N. B. the terminus on the Atlantic, is not as yet completed, and the funds for its completion, under present circumstances, may not soon be available. Many expectations founded on its opening up rich territories in Ontario and Quebec will be disappointed for a while.

Science

The "Thinking" Horses of Elberfeld were not, after all, killed in battle in Flanders, as has been reported in the newspapers and many scientific journals. According to a note in *Science*, the owner of the horses, Herr Krall, reports them safe and sound, though the experiments on them have been suspended during the war.

The British Association.—Under the heading "Science as Usual," *The Times* announces that the British Association will hold its annual meeting in Manchester next September, as arranged. On account of the war the meeting will probably be shorn of the elaborate social functions which usually characterize this annual event.

The Work of the Coast and Geodetic Survey.—A substantial illustrated pamphlet, issued especially for distribution at the Panama-Pacific Exposition, but also obtainable by mail, free of charge, from the Division of Publications, Department of Commerce, Washington, D. C., is entitled "United States Coast and Geodetic Survey; Description of its Work, Methods, and Organization." The varied and useful activities of this branch of the Government are set forth in interesting detail.

Disturbance of Pheasants by Distant Cannonading.—*The Times* and other English publications have contained numerous accounts of the disturbance noted among the pheasants of northeastern England during the North Sea battle of January 24th, apparently indicating that these birds heard the cannonading—so plainly as to be much excited thereby—though in most places it was imperceptible to the human senses. An alternative suggestion, offered by Dr. Davison, is that the disturbance of the birds was due to the sudden swaying of low trees and shrubs under the effect of inaudible air-waves.

A Great Sun Spot Appears.—A great sun spot estimated to be 100,000 miles long has been disclosed by the recent development of a photographic plate that was exposed at the Naval Observatory, at Washington, on March 29th. The following instructions are given by the observatory officials for observing the spot. "By holding a piece of smoked glass in front of one of the object glasses of an ordinary opera glass, with the smoked side toward the opera glass and looking through this side only, using one eye, the spot may be plainly seen. Caution should be observed not to get the full glare of the sun in the eye, and the side of the glasses not in use should be turned away from, instead of toward, the other eye, so as to avoid the possibility of the sun's rays striking that eye through the glass."

Trees that Keep Weather Records.—In cutting up logs for experimental purposes at the Madison, Wis., laboratory of the U. S. Forest Service it was noticed that in a number of them there were little diagonal streaks, or wrinkles, running across the grain, and that these appeared entirely on the same side of the trees. It was well known that these wrinkles indicated compression failures, such as result from too great a strain on the fiber at some time, either from bending in a storm, or from rough handling; but as all of the logs in question came from the same locality in Florida, and the markings were all on the north side of the log, it was assumed that they were caused by some severe storm from the south that had swept over that part of the country. By carefully counting the annual rings of wood, and knowing when these trees were cut, it was decided that the storm recorded by the wrinkles must have occurred in the year 1898; and inquiries verified the fact that at that time a hurricane had swept over that region.

A New Immunization Theory.—According to a new theory of immunization against bacterial disease evolved by Drs. Henry Smith Williams and James Wallace Beveridge, two New York physicians, the red and white corpuscles of the blood are the chief agents that protect human organisms against the ravages of bacteria, and this they have termed the proteomorphic theory. These investigators believe that the white corpuscles deal with the unbroken proteins that they may come in contact with, whether they be of bacterial or dietetic origin, and that the red corpuscles deal with the partially cleaved molecules of protein. In other words, the business of the white corpuscle is to break down or cleave this protein molecule, not synthesize it. And in summing up *American Medicine* condenses their statement: "In this view, then, the red blood corpuscles have an immunizing function strictly complementary to that of the white blood corpuscles, and no less important. One legion of cells co-operates with the other, each having its own special field. The white corpuscle deals with all formed bodies and full-sized protein molecules of foreign type that make their way into the blood stream. The red blood corpuscle deals with the later cleavage products of protoplasmic activity. In carrying out their respective tasks, the leucocyte supplements the work of the ferments of the digestive tract; the red corpuscle supplements the work of the leucocyte and relieves the ultimate tissues in considerable measure of the task of protecting themselves against small-moleculed nitrogen products that might prove harmful."

Astronomy

The Royal Astronomical Society has decided, by a vote of 59 to 3, to admit women as fellows and associates.

"L'Astronomie," the monthly bulletin of the Astronomical Society of France, which suspended publication at the outbreak of the war, has now been resumed, and the missing back numbers have been issued, so that there will be no break in the files.

Arthur von Auwers, the well-known German astronomer who died January 24th of this year, was born in Göttingen in 1838, and moved to Berlin in 1866 when he became a member of the Berlin Academy of Sciences and academic astronomer. Auwers was pre-eminent among European astronomers in studies on the proper motion of stars, but also made many important investigations in other branches of astronomy.

Adam Massinger, assistant at the Heidelberg observatory and known as the discoverer of several asteroids, was killed in action near Ypres October 21st. It is an interesting example of the irony of fate that Massinger named the first asteriod he discovered "Nipponia," in honor of Japan. During the last few years he had been engaged on a laborious examination of all the nebulæ of Herschels' general catalogue found on the Heidelberg photographic plates, and was preparing to use the statistical material thus collected concerning upwards of 4,400 of these bodies in a study of their distribution in the stellar system.

New Asteroids.—The Astronomisches Rechen-Institut, at Berlin-Dahlem, announces that 76 new asteroids were discovered in the year ended June 30th, 1914; viz., 26 at Heidelberg, 5 at Johannesburg, 1 at Nice, 1 at Paris, 19 at Simeis, 3 at Vienna, and 20 at Winchester, while 1 was discovered on the same night at Heidelberg and Simeis. Permanent numbers have been assigned to 32 of these, as well as to 5 discovered the previous year, and the elements of these 37 have been published. The total number of these bodies whose orbits are now definitely known which have consequently received permanent numbers is 791.

Saturn's Crepe Ring.—The crepe ring of Saturn has been observed and measured at the Lowell Observatory persistently wider on the east than on the west side of the planet during the past month by a difference of five hundredths. This fact will have important bearings on the mechanics of the stability of the ring. Any phase effect or defect of illumination of the constituents of the ring are not sufficient to explain the phenomenon on account of the diminutive size of the meteorites composing it. A possible explanation of this detected eccentricity of the ring may be the revolution of its perisaturnium.

The German Eclipse Expedition in Russia.—Four German observatories—Berlin, Hamburg, Munich and Potsdam—sent expeditions to the Crimea to observe the solar eclipse of August 21st, 1914. These parties reached their stations about the end of July and were busy with preparations for their work when the outbreak of the war caused them to depart hastily for Germany, leaving their instruments behind at Theodosia. Having proceeded as far as Odessa by boat, they were all declared prisoners of war. Ultimately most of them were released and got home in safety, but four—viz., Dr. Zurhellen of Berlin, Dr. Kühl of Munich, and two assistants of the Hamburg party—were kept in captivity, and are supposed to have been sent to Astrakhan. The instruments left at Theodosia were confiscated by the Russian authorities and turned over to the University of Odessa.

Early Chinese Records of Eclipses.—Messrs. Hirayama and Ogura have published in the *Proceedings* of the Tokyo Mathematico-Physical Society the results of their attempts to fix the dates of some early eclipses recorded in Chinese literature. The earliest is mentioned in one of the books of the Shu Ching, where it is recorded that in the reign of Chung K'ang, the fourth emperor of the Hsia dynasty, there occurred an eclipse of the sun which had not been predicted by the astronomers, who were alleged to have been drunk and to have neglected their duties. Hence the customary rites for delivering the sun, which should have been arranged in advance and superintended by the astronomers, were in the emergency performed by other officials without proper preparation. The emperor accordingly ordered the army to punish the astronomers. A later document makes it possible to fix the date of this event as October 13th, 2127 B. C. (Julian calendar)—the earliest recorded eclipse in the world. Calculation shows that there actually was a solar eclipse on that date, but probably not in China, though the elements of the motions of the sun and moon are not accurate enough to indicate certainly the path of so remote an eclipse. The authors are inclined to think that the information fixing the date of the eclipse is due to Chinese astronomers of a later age, who calculated that an eclipse occurred on that date and erroneously supposed that it was visible in China.

Automobile

Wanted: 20,000,000 Tires in 1916.—Granting that the average consumption of tires by motor cars is eight tires per car per year, which includes all types of vehicles, there will be required during 1916 not less than 20,000,000 tires, valued at from $300,000,000 to $400,000,000—figuring the average price of tires at $15.

Lubricating Spring Leaves.—A new device for the lubrication of the leaves of automobile springs has been brought out by a Providence firm. The device is essentially nothing but a pair of plates, bolted one on each side of the spring. Each plate incloses a small oil reservoir and a felt wick, the latter pressed against the edges of the spring leaves and feeding the oil between.

New Aluminium Solder.—A solder for aluminium which can be used without flux, has been evolved by a New York company, which sells it by the pound, in convenient sticks weighing about 5 ounces each. The solder is applied with any convenient piece of iron, while the heat of a gasoline torch is all that is necessary to cause junction. At the soldered joint the metal is stronger then the aluminium itself. The aluminium will not oxidize during the soldering.

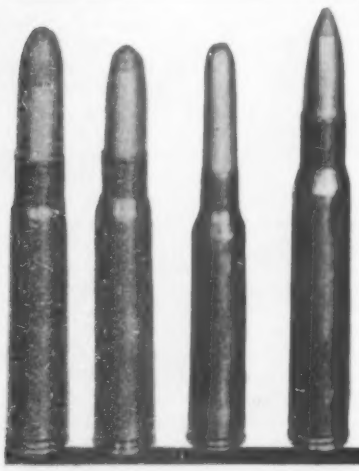
Ball Bearings Still Imported.—Fears that the imports of ball bearings would completely cease because of the war, appear to have been groundless. Despite the embargo placed by the German government upon bearings exports, the quantity and value of these necessities for motor cars have not been less in the seven months ended January 31st, 1915, than in the same period ended January 31st, 1914. Most of the shipments now come from Italy and Sweden.

A Rubber Regenerator Wanted.—A prize of $25,000 has been offered by the German government for a satisfactory process of regenerating rubber. It is not merely a "reclaiming" process that is desired, but a real "regenerating" process. The resiliency of the original rubber must be regained to an extent of at least 90 per cent in order to make the process eligible for competition. The tire problem is beginning to worry the army authorities, and negotiations are said to be pending with the manufacturer of a well-known fiber tire, of the tension type, which is expected to solve the difficulty of obtaining rubber for pneumatics in sufficient quantity for army needs.

Safety Devices for Automobile Starting Motors.—A patent has been granted F. H. Miller of Wilkinsburg, Pa., assignor to Westinghouse Electric and Manufacturing Company, No. 1,130,004, for a safety device for starting motors of automobiles. The object is to protect the gears of a starting motor for an automobile engine by preventing the connection of the motor to the engine shaft when the latter is rotated above a predetermined speed and in doing this the party utilizes centrifugal force to control means for preventing the establishment of an operative connection between the starting motor and the engine shaft. Another patent, No. 1,130,573, for a similar purpose has been issued to Frank Conrad of Liversvale, Pa., assignor to Westinghouse Electric and Manufacturing Company, in which patent there is employed the usual reduction gear mechanism which operatively connects the motor to the engine fly wheel, and the invention provides a device which automatically locks the starting mechanism in an inoperative position when the fly wheel is rotated but allows the connecting gears to mesh if the fly wheel is at a standstill, thus avoiding any operation of the starter when the engine shaft is operated.

Saving Time by Combination.—One of the most peculiar results of the modern system of quantity production of automobiles is undoubtedly the tendency to combine certain accessories, in order to save material and, especially, to save time in the assembling of the car. A few minutes saved in the putting together of the minor parts of the car, means an aggregate saving of many days' work when a production of 50,000 or more cars is concerned. Some of the most recent attempts along this line are the following: One company is using a headlight with hollow perforated rim. This rim is really the horn end of the electric warning signal, the buzzer of which is directly behind the electric light bulb. Not only is the mounting of the horn unnecessary, but the sound is carried forward better, because of the absence of interfering parts. Another company uses a headlight, in the back of which is mounted a mirror, thereby combining the two accessories which heretofore had to be mounted separately. Still another concern mounts its electric lighting generator on the cooling fan, while a fourth combines the horn with the fan. The use of the magneto as a generator for electric lights is coming into favor more and more, the largest American manufacturer just having announced that in future models a slightly larger magneto will be furnished without extra charge, in combination with a complete electric lighting installation. The next two years will undoubtedly see many similar combinations, reducing the number of parts, the number of odd angles to the car, and the time and expense of assembling the car. The lowest priced cars probably will lead in this respect.

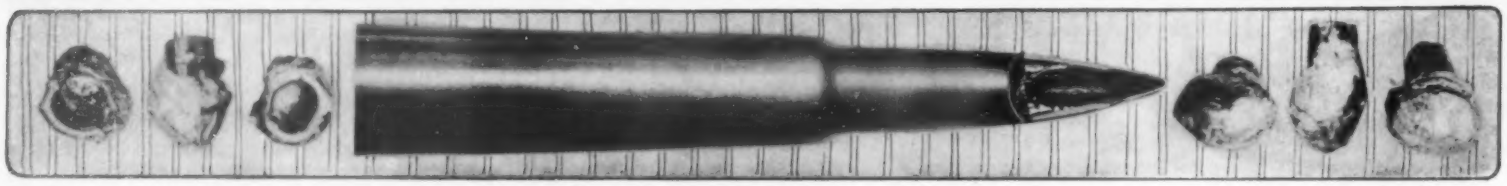
Dum-dum cartridges, all forbidden by laws of war. First three have soft point bullets with metal patches of varying length. No. 4 has a soft point Spitzer bullet.



No. 5 is a 250-grain Savage; 6, British "Mark IV," the original hollow point dum-dum; 7, copper tube expanding Spitzer, used for big game; 8, hollow nose sectioned to show form.

Dum-dum Bullets

By Edward C. Crossman



Dum-dum bullets after firing.

Expanding Spitzer bullet sectioned to show hollow copper jacket that makes the bullet break up.

Dum-dum bullets after firing.

THE dum-dum charges on both sides take us back to the days of the Spanish war, when the same accusations were made. As a matter of fact, Spanish 7-millimeter cartridges could be produced with the point of the bullet sawed criss-cross with a hacksaw, but at that we doubt its being any more deadly than the ordinary bullet.

With the exception of the French, the belligerents in the present war use smokeless high-velocity rifles of small bore and, of course, firing jacketed bullets. These bullets are constructed of a lead core, with a tough jacket or skin over the outside, closed everywhere except at the base where the core is inserted. This very tough skin is made either of sheet steel, nickeled to prevent rust, or else of an alloy of copper and nickel of about the proportion of 20 per cent nickel to 80 per cent copper, and being thus merely German silver. Sawing the point off a sharp point bullet of this construction does not cause the bullet to break up in tissue, unless the cut is made far down the bullet.

All the nations engaged use practically the 0.30 caliber, although, of course, the cartridges vary considerably. No, they are not 30-30's, nor any relation to 30-30's, the 0.30-30 being an American game-shooting cartridge of considerably less power than a military cartridge.

Now early in the small bore, jacket bullet game, the British found themselves in difficulties with some hill tribe or other. These Afghans or similar East Indian Apache, were accustomed to rush British camps by the light of the stars, or sometimes by daylight, and brandish knives as large as *machetes* and as sharp as razors.

The first thing the British discovered about their new small bore acquisition in place of the good old 0.45 caliber Martini Henry, was that the new rifle would not stop an Afghan or other hill person, who really intended to keep coming. Several British soldiers were killed by hill men who, according to all the laws of warfare, should have been very, very dead. Drilling them with the 0.303 seemed merely to exasperate them. Therefore, in their hill arsenal of Dum-Dum, the British proceeded to evolve a new bullet for making good men out of hill men. They took the 0.303 bullet and removed some jacket from the point, exposing the leaden core. Then they tried it on some more hill men. The British troops reported that it was fine. No word was ever received from the parties on the other side. Thus arose the first soft point, metal-patched bullet, and on it was saddled the name of Dum-Dum from the little, obscure Indian arsenal that produced it. And so, every bullet from a small bore rifle, doctored up in any way at all, was yclept Dum-Dum, although it might use some other system for procuring expansion of the bullet. Also any wound that was unseemly large was promptly charged up to a dum-dum bullet, although it might just as well have come from a bullet ricocheting from rocky ground, or in these modern days from a sharp point bullet in its original tumbling act.

The British proceeded to change this dum-dum bullet around a bit, making it hollow nose, instead of exposing so much lead, but still designing it to expand and break up on impact. It was officially recognized and named, as we remember, the Mark IV, the British so naming every separate cartridge and rifle they ever produced.

They found it just as pleasing in Africa. They laid out Dervishes with it, and they stopped Matabeles and other members of the Zulu nation. With the last, particularly, the ordinary bullets proved ineffective. When an impi started for the British line, the members thereof kept on coming until physically unable to move on. The regular bullets were inadequate. We have before us a half dozen of the hollow nose bullets used by the British in the Matabele trouble.

At The Hague or Geneva Convention, we forget which, the British, with other civilized nations, signed compacts forbidding the use of expansive or explosive bullets. The bally heathen had nobody at the convention, which was a little tough on the heathen.

But the French, against whom the dum-dum charge was brought, have as clear a case of alibi as any small boy who could prove that he was stealing apples out of an orchard a mile away, when the melon patch was raided.

Exposing the lead of a patched bullet or giving it a hollow nose tends to make the jacket peel back and split up in ribbons, allow the lead to fly off in small bits, and the main body of it to flatten out or mushroom.

But the French use exclusively a bullet formed of solid copper-zinc alloy, no jacket, no lead, no soft metal to smear around regardless of what one does to the bullet. It could "dum-dum" about as easily as a piece of heavy copper wire. The German charges were disproved the instant we saw at whose door they had been laid. The French soldiers—some of them—in their ignorance might have sawed at the points of the bullets or cut them through, or otherwise fussed around with them. Instances of the sort are common in every army, including our own. But, regardless of the intent of the few scattered fools that might have done this, the effect was *nil*, because you cannot do anything to a solid copper-zinc bullet to make it more deadly.

Copyright by Underwood & Underwood.

Clip of British cartridges transfixed by a German bullet while in a soldier's bandolier.

Also, Germans protested because the French cartridges were poisoned. They found a ring of black stuff around the neck of each cartridge. I have one before me, and it is not a pleasing cartridge in appearance. I know of other cartridges I would select in preference were I planning to be shot—say the B. B. or 0.22 Short for choice. This black stuff turned out to be a waterproofing, and about as poisonous as Munich beer.

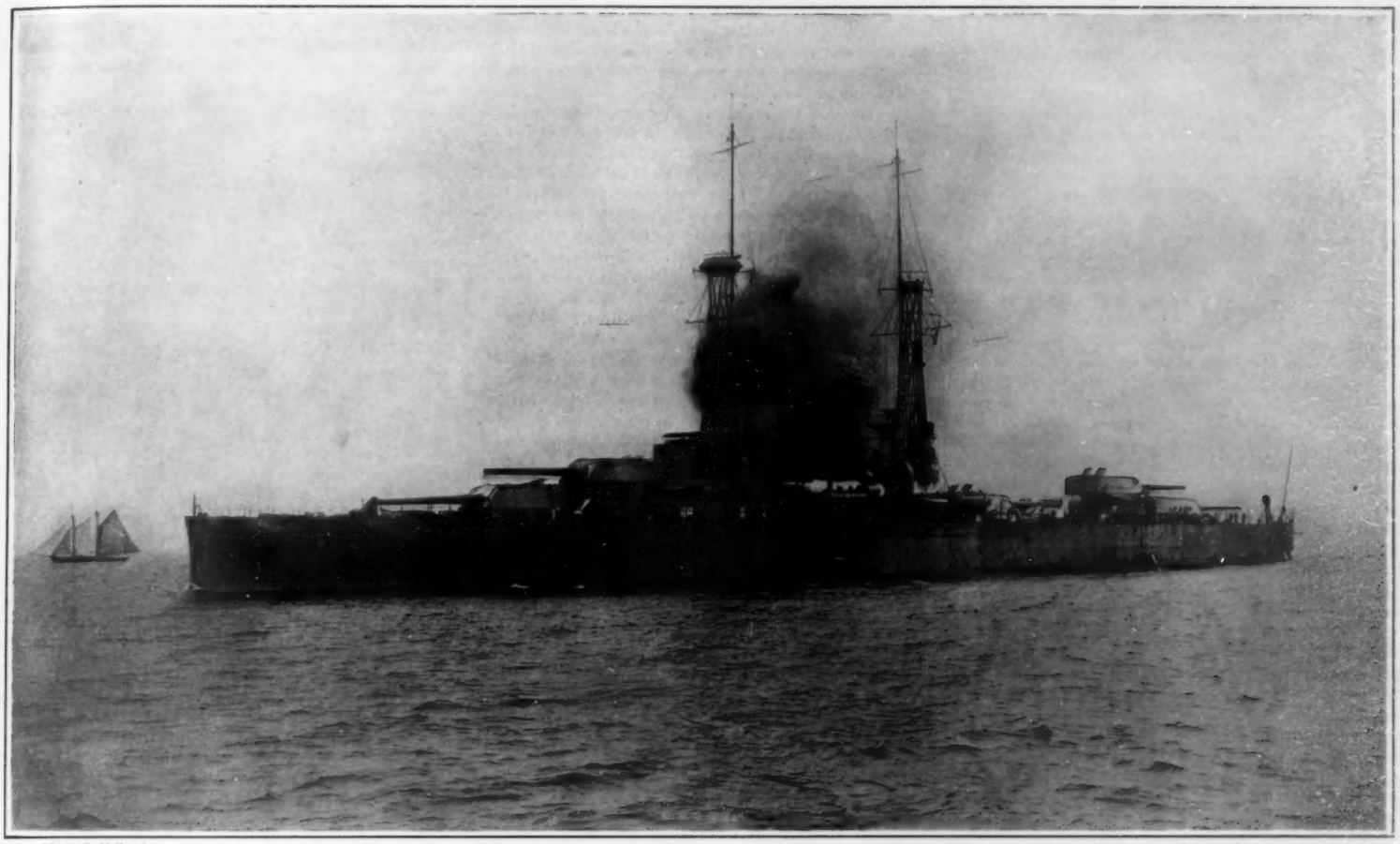
If the dum-dum charges had been leveled in later days of the war, and at the British, it might have aroused suspicions among those that knew the facts that the British had by mischance been shipped some of the old Mark IV hollow nose bullets, but I, for one, refuse to believe that they ever would use them deliberately.

As a matter of fact, consider the manifest stupidity, not to say childishness and lack of sportsmanship that lies back of all this dum-dum folly. Altering a bullet on a wholesale scale would result in inaccuracy, altered ballistics of the rifle, chances for trouble if the bullet broke up in the barrel as happens if the point of a solid jacket bullet is sawed off, and general trouble all round, not to mention the small job of altering a few billion rounds of cartridges urgently needed on the firing line. And, were all this done, the net result would be a few men killed that otherwise might have lived, a few wounds of far nastier type, and a few less wounded for the surgeons to patch up.

When a man is hit by any modern or old style bullet he usually quits. I speak now of civilized troops. The Russians quit before the tiny 0.25 caliber bullets of the Japs. The little 0.25 caliber bullets did just as effective work in the Balkans as the 0.30 caliber bullets. Once in a while a man might keep on fighting with a hole in him, but he is not worth while breaking all the laws of civilized fighting for, to say nothing of the trouble entailed in altering the bullets used.

Therefore, if you stop the advance of the enemy you've done all you can. The condition of his wounded does not interest the men on the other side. Nobody but a heathen would want to think of the wounded of the other side lying in agony from torn wounds of explosive bullets. Dum-dum bullets don't help to hit any more men, and it is hitting the men at all that is the difficult and the decisive thing in war.

On the other hand, the surgeons of both armies do find men badly torn, with slashing wounds that apparently never could be produced by anything but expanding bullets.



Copyright by E. Muller, Jr.

Date, 1913. **Tons,** 27,000. **Speed,** 21 knots. **Guns,** Ten 14-inch, twenty-one 5-inch. **Torpedo tubes,** 4. **Belt,** 12-inch.

U. S. S. "Texas," the first of our battleships to mount the 14-inch gun.

An Analysis of Our Naval Standing—II

Why We Are An Inferior Power

By George von L. Meyer, Former Secretary of the Navy

IT has been held that the possession of a sea-going fleet having rapidity of movement and the ability to keep the sea insures without doubt the transference of a hostile attack to some point at sea at a great distance from our home shores and an ability to maintain a free highway for American commerce under conditions where the submarine would be practically powerless. That is true only in the sense that battleships are, and may indefinitely remain, the controlling factor in any war in which the belligerents are separated by great distances of water, but it is not always feasible for a battleship fleet to leave home waters. The powerful fleet of British dreadnoughts is, so far as known, within a few miles of any point of the British coast. Its past or future vulnerability for German submarines is something that will not be known until long after the end of the present war.

The North Sea and the British Channel constitute a body of water whose coast lines, on all sides, are never widely separated. The location has given the submarine a safe field for action and has correspondingly limited the usefulness of the dreadnoughts, which are, in reality, doing no more than patrol duty. Our home waters would never offer an identical situation to a hostile fleet if we exclude the Caribbean Sea. But in order to retain the command over that sea a powerful fleet would be necessary. Therefore the ratio of submarines to capital ships must be maintained on the basis recommended by the General Board if we wish to consider ourselves safe.

In view of the increasing number of submarines, however, and the age of some of the older vessels, there is urgent need also for testing and wrecking docks that may be used for salving submarines of any size, docking submarines, and testing to determine resistance to external water pressure. Two docks of this description will ultimately be required for the Atlantic, and one each for the Pacific Coast Hawaii, Panama, Guam and the Philippines.

Two other types of auxiliary ships are required for the successful administration of the fleet—hospital and supply ships. The two hospital ships now borne on the navy list—the "Solace" and the "Relief"—are both improvised and small, and neither adapted to the service. They have done good service in time of peace in connection with subdivisions of the fleet, but the "Relief" is now *unseaworthy* and the "Solace" would be of limited value in time of war. To remedy this defect the General Board repeats the recommendation for the 1916 programme, as it again recommends an additional supply ship. One, authorized in 1913, is now under construction, but another is needed, because the four ships we have are improvised and were hurriedly bought and fitted in 1898 to meet the exigencies of the Spanish war. Upon the efficacy of the supply ships depends the efficacy of the fleet when it is away from home waters or its base. This question of supply ships has again been demonstrated in the present war, and though the source remains a secret it is known that the German system of supply has been marvelous. Up to the time of writing not one German cruiser was forced to intern or surrender because of lack of supplies. Some of these supplies, true, may have been obtained from vessels of the enemy, but I do not doubt for a moment that Germany (or any other power) has a perfect system of supply and the proper number of ships to do the supply work.

Two other important items should be considered; one relative to a floating dock and another for coaling stations.

Graving docks of 1,000 feet for both the Atlantic and Pacific, to accommodate newer and larger vessels, are necessary, to be located at places subject to later selection. But the construction of a floating dock of about 40,000 tons capacity is necessary. Such a dock is indispensable to float a battleship or cruiser that has been injured or wrecked or crippled on any part of our coast. The dock must be large enough and strong enough to hold the heaviest dreadnoughts. We have now only two floating docks, one in the Philippines and one at New Orleans. The latter will float a battleship of about 15,000 or 16,000 tons, although doubt exists in some minds as to whether it would be safe to float a 16,000-ton ship—the absolute limit of its capacity. Such a dock ought to be stationed on the Atlantic, although there was an element in Congress, when I first recommended this dock, that suspected a hidden motive. But if doubt existed then as to the desirability of such a dock, the present war has likewise demonstrated the value of this equipment, which forms a part of the German and British navies. One of the latest reports is that the "Audacious," the dreadnought which was rendered useless on the Irish coast late in October, is now supposed to be undergoing repairs, and these repairs are only possible because the huge dock was taken to the scene of the disaster.

We are likewise confronted with the necessity for large reserve supplies of coal. The navy lacks adequate coal and fuel depots at several important strategic points, notably Guantanamo, Puget Sound, and Pearl Harbor. Arrangements have been made to increase the capacity and facilities at these places as far as practicable with the funds that have been available from time to time, but a considerable additional appropriation for the purpose is necessary in order to achieve the desired result.

Without ample coal and oil storage capacity at the distant bases, and in the absence of a large merchant marine to insure a continuous supply of fuel, the activity and effectiveness of the fleet will be seriously, if not fatally, affected in time of war. An item of $500,000 would perhaps cover the requirements.

There has been a tendency in certain congressional quarters in favor of a general naval base located somewhere on the mainland of the Gulf coast. This plan has been taken up by the joint board of the Army and Navy, but its unanimous recommendation has been for a naval base on the Atlantic coast. But in order to consider this point we must disregard existing naval stations. The interests of the country and the interests of the Navy would be best served by the establishment of one first-class naval station with ample anchorage on the coast north of the Delaware, equipped for docking, repairing, and provisioning at least half the entire fleet, and one station of the same capacity at Norfolk, in Chesapeake Bay. This would be supplemented by a fleet rendezvous at Guantanamo with sufficient docking and repairing facilities to enable the fleet to maintain itself in that vicinity for considerable periods, but not for extensive repairs; an ample torpedo-boat base at Charleston; a supplementary torpedo and submarine boat base at Key West, and a station for the large reserve fleet at Philadelphia. The fresh water basin there is to be the port of the reserve fleet of battleships, and the department has been studying the system which will put these ships in such a condition that they will be ready at the shortest possible notice and at the same time will not deteriorate.

Now we must consider the personnel.

For the first time in many years the enlistment is up to the limit prescribed by Congress. The enlistment at

present is 52,667, or 4,612 greater than last year. This increase was made possible by recruiting to the additional authorized strength. It is estimated that about 90 per cent of the effective fighting power of the Navy is now fully manned. But one cannot hide the fact that although the numbers are recruited up to the limit allowed by law, we have only sufficient men to man in an adequate manner a portion of the vessels already built. At present three second line battleships, two armored cruisers, two third-class cruisers, twenty-one destroyers, three monitors, five submarines, one gunboat, three fuel ships, and two vessels of special type are in commission in reserve; that is to say, they have on board from 25 per cent to 50 per cent of the crews necessary to man them in case of war. There are also 6 second line battleships, 1 armored cruiser, one second-class cruiser, and 14 torpedo boats which are in the condition technically called "in ordinary." These vessels are manned from 10 per cent to 20 per cent of their regular complements—just enough to prevent them from *rusting to pieces*. Further, there are 3 second line battleships, 3 second-class cruisers, one third-class cruiser, one destroyer, two monitors, four torpedo boats, 6 gunboats, one transport, one hospital ship, one fuel ship, one repair ship and 11 converted yachts which are at present out of commission altogether.

To provide a proper complement for all vessels of the Navy which could still be made useful for war purposes would require an addition to the present force of about 18,000 men.

As things stand, building battleships or other warships without having an adequate force of men is equal to wasting money. For instance, a statement issued by the Navy Department recently reads that "theoretically, and on paper, the Navy possesses at the present time ten battleships of the first line and twenty-three battleships of the second line, but actually only the ten battleships of the first line and eleven battleships of the second line can be placed in commission for service because of the *shortage of men*." The foregoing totals, however, do not agree with the official table showing the naval standing of the powers.

Whether or not the practice of taking the crews from the older ships to man new ships is a wise one is doubtful. It may be true that 800 men on a dreadnought of the latest type are as effective as 4,000 men on old battleships or old cruisers, but I am convinced that all serviceable vessels—regardless of their class—ought to be fully manned, and that for every additional warship added to the fleet an adequate number of enlisted men should be provided for. If men must be taken from one old ship to man a new one, the change ought to take place in those instances where the ship is actually retired and condemned as unfit for further service.

The General Board, in its latest report to the Secretary of the Navy, states as follows:

"The General Board cannot too strongly urge upon the Department the necessity of using its best endeavors to carry out the repeated recommendations of the General Board, made from year to year, to provide the fleet with a personnel, active list and trained reserve, equal to the manning of the fleet for war. In the opinion of the General Board this is a matter of even more serious import than that of construction, for it cannot be too often repeated that ships without a *trained* personnel to man and fight them are useless for the purposes of war. The training needed for the purpose is long and arduous, and cannot be done after the outbreak of war. This must have been provided for long previous to the beginning of hostilities; and any ship of the fleet found at the outbreak of war without provision having been made for its manning by officers and men trained for service can be counted as only a useless mass of steel whose existence leads only to a false sense of security.

"The strength of fleets is measured too often in the public mind by the number and tonnage of its material units. The real strength of a fleet is a combination of its personnel—with their skill and training—and its material; and of these two elements the more important—the personal—is too often forgotten and neglected in making provision for our fleet."

This last paragraph is worthy of attention not only by Congress, but all the people. We alone of the naval powers provide no trained reserves. We trust to the filling of the complements of our ships by untrained men recruited after war is imminent or declared!

Of course, no nation in time of peace keeps all the ships of its navy fully manned and in full commission. But all the leading nations except the United States provide an active list, officers and men, sufficient to keep the best of their fleet in a material condition for war; and in addition a trained reserve of officers and men sufficient to round out the complements and fully man every serviceable ship of their navies, and also furnish a reserve for casualties. Thus every nation except ours is prepared to mobilize its entire navy, by order, with officers and trained men.

Congress, however, will not be officially acquainted with the fact that the General Board is earnestly seeking a greater personnel list.

Yet the need of more men is a serious one. The requirements are as follows:

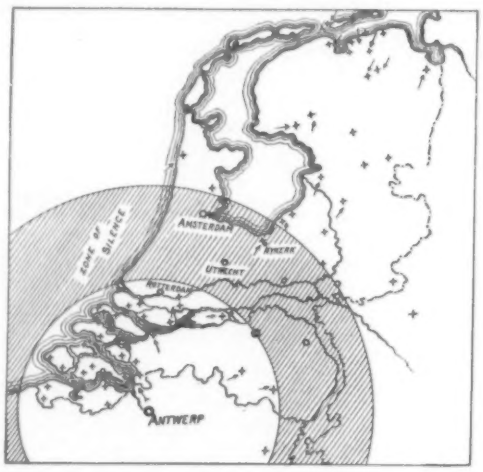
1. Provision for an active personnel, officers and enlisted force, capable of keeping in full commission all battleships under fifteen years of age from date of authorization, all destroyers and submarines under twelve years of age from authorization, half of the cruisers, all the gunboats and all the necessary auxiliaries that go with the active fleet.

2. To expand the active personnel with the expansion of the fleet in the proportions indicated in the preceding paragraph.

3. Taking immediate steps to form a national reserve of trained officers and men, and that his work be pushed until this reserve in connection with the naval militia has reached the point where, combined with the active list, it will be possible to man the entire fleet with war complements and furnish an additional ten per cent for casualties.

If we could get a reserve of 50,000 men, half of whom have been in the Navy and the other half in the mercantile marine service, either on the Lakes or along the coast, then we would have a personnel emergency reserve which would be of great value in time of need. Our present naval militia is insufficient, as it numbers about 7,000 men. We need a reserve to make up the personnel deficiency.

Let us not forget that this country possesses potentially a well-trained and capable naval reserve, but it is unorganized and it is at least 10,000 men short. Plans ought to be made to organize this body of reserves that would make of it an effective reserve in time of war. There are about 30,000 of these former sailors, men fit by physical strength and experience both to officer and man naval auxiliaries, as well as



The shaded area marks the zone in which the bombardment of Antwerp was inaudible.

to return to their places as gunners, gun pointers, and other positions on our warships.

We have more vessels in commission than most of the nations which give higher rank to their officers, yet when our fleets enter foreign waters our naval officers are compelled to yield precedence to ranking officers of smaller nations. This is not an indignity to the man so much as to the United States. It is not a question of our naval officers, as individuals, being placed in inferior positions when they meet the fleets of other nations. It is that in the eyes of other nations we put ourselves in the position of *an inferior power*.

And another deficiency worthy of notice is the fact that it would be practically impossible for the United States Navy to make any strategic move outside of American waters unless it first obtained, by purchase or otherwise, British admiralty charts to insure safe navigation. How soon the United States will become independent of chartmakers I do not know, but the fact stands that we lack a very necessary item.

There has been a great deal of comment about the unreadiness of the fleet to-day. During the past two years maneuvers and battle practice of the fleet as a whole have been greatly curtailed. The last mobilization, in the full sense of the word, was during the last Administration in October, 1912, when 31 battleships, 4 armored cruisers, and 88 smaller vessels, manned by 1,300 officers and nearly 27,500 enlisted men, participated in the review. Since then the custom of annual mobilization has been abandoned. Why? Because the present Administration has required the use of battleships for duty which could have been performed equally well by gunboats and small cruisers. In addition, the shortage of men is also seriously interfering with the annual maneuvers so necessary for the efficiency of the fleet. Vessels for such service are almost rusting away while "in ordinary," and the battleships suffer because emergency duty prevents their mobilization and proper drills.

Are not the foregoing circumstances worthy of attention? Are there not many defects which should be eliminated? Is not the present policy a costly and roundabout one?

Zones of Silence

By W. J. L. Kiehl

PROF. VAN EVERDINGEN has published the preliminary conclusion arrived at in the Meteorological station of Utrecht about the area in the Netherlands where the bombardment of Antwerp was audible. More careful study has, however, to be given to the matter before it can be understood in all its phases, for instance the bearing thereon of the local weather conditions have still to be more especially investigated. The broad conclusion that could at a glance be deduced from the reports that came in from various places in Holland after each place where the bombardment had been heard had been marked on a map (see accompanying diagram) have absolutely confirmed the theory of the German scientist, Dr. Von dem Borne, who suggested that the phenomenon of zones of silence correspond to a similar phenomenon in light, which produces the well known *fata morgana* of the desert. According to this theory the sound waves which are thrown upward do not lose themselves in infinity, but, after reaching a height of from 60 to 80 kilometers (37 to 50 miles) according to the greater or less density and dampness of the atmosphere are thrown back again or reflected toward the earth.

The area over which the sound of the bombardment was directly audible was a very wide one, about 85 kilometers in radius. Then follows a zone of silence of 60 kilometers broken only in one place (see the small cross near Nykerk on the map). What local atmospheric condition caused this exception has not yet been ascertained. Beyond this zone the sound again became audible and the direction from which the observers perceived the sound is given by the small arrows on the map. It will be seen that in the extreme north of the province of Groningen the sound of guns was heard coming from the northeast, and upon investigation it proved that simultaneously with the bombardment of Antwerp, October 7th to 9th, gun practice at Borkum was going on and also at Meppen, where Krupp gun ranges are situated. This group of crosses will, therefore, have to be eliminated. It is interesting to note that at Utrecht itself the sound of the bombardment of Antwerp was not heard, but when, later on, the fighting line in Belgium was removed to a distance of 200 kilometers from Utrecht the sound of guns was plainly discerned, both by Prof. van Everdingen himself and others of the observatory.

Prof. W. Meinardus of Munster in Westphalia happened to hear of the investigations carried on at Utrecht and sent Prof. van Everdingen a clipping from the *Münster sher Anzeiger* of October 10th, in which appeared letters from persons in places some 180 kilometers distant from Antwerp, to the east and northeast, who not only distinctly heard the sound of guns, but were able to distinguish the difference in sound between the report of the 42-centimeter guns and others. He offered to collect further material upon this matter in Germany and send it up to Utrecht. This offer was gladly accepted, for, in this way, it may be possible to determine the width of the outer sound area.

Prof. van Everdingen intends to publish the results of further investigation later on.

The Current Supplement

THE issue of the SCIENTIFIC AMERICAN SUPPLEMENT for April 17th, 1915, No. 2050, is most valuable in the variety and character of the matter it contains. There is an interesting account of the earthquakes and volcanic eruptions of Sakurajima, in Japan, showing their connection with other disturbances in this region. Testing the Sensibility of Plants is a valuable summary of the remarkable investigations by Prof. Bose, which have opened up an entirely new field in plant physiology. There is an interesting account of the zoological achievements of the Roosevelt-Rondon Expedition in South America by one of the scientific party. Wireless Transmission of Energy is an unusually clear and complete exposition of a subject of growing importance, written especially for the general reader by a leading authority. The Uses of Light in the Treatment of Disease adds much to our knowledge of the effects of different kinds of light. An English authority on aeronautical subjects reviews many of the important doings of the airman on both sides in the European strife, with comments on the results accomplished. There are articles on printing for the blind, German railways in the war and various other matters.

Teaching Defective Children

The Remarkable Experiment of Columbia University in Educational Psychology

By A. M. Jungmann

A SERIOUS problem in educational psychology is that of developing the mental faculties of exceptional or atypical children. Up to within recent years mental defectives among children were looked upon as hopeless and very little was attempted in their education. To-day, however, it is generally recognized that many forms of defective mentality are amenable to treatment along lines evolved through a better comprehension of those branches of medical science known as psychiatry and neurology.

An interesting experiment in the education of exceptional children is now being carried out in Columbia University. A class of atypical children has been formed in Speyer School, a model elementary school used for experimental purposes in connection with Teachers College. Psychologists recognize that the training of exceptional children must differ from the training of normal children in that each child requires individual study and the instruction it receives must be particularly suited to its requirements. In order that the greatest possible progress be made by the class as a whole the number of pupils has been restricted to ten children, thus permitting each child to receive the maximum amount of attention from the teachers and preserving, in all essentials, the individuality of each student.

The examination of the children who were admitted to the class was conducted by Dr. Louis E. Bisch, who has been very successful in the treatment of atypical children, and Dr. Naomi Norsworthy, Associate Professor of Educational Psychology. Before acceptance each child is thoroughly examined physically and mentally. Absolutely hopeless cases are not accepted. In his mental examination Dr. Bisch employs the Binet-Simon measuring scale for intelligence, the Yerkes-Bridges "point scale" and the Ziehen intelligence test. In the recognition of mental deficiency each of these tests has certain peculiar advantages. The point scale was designed by its authors with a view to improving the Binet measuring scale of intelligence. The test devised by Prof. Ziehen of Berlin University, has been used with highly satisfactory results in the psychiatric and neurologic clinic of that institution.

The Binet-Simon test has the advantage of instantly appealing to the child. Practically all children like to look at pictures, and if the examiner begins by asking the child to look at the pictures used in the test the child is at once placed at ease and will respond to the questions in a natural manner. It is essential that the examiner gain the confidence of the child. The questioner must assure himself that the child is entirely at ease if successful results are to be obtained. The child should look upon the examination not as an examination, but as a game which he takes pleasure in playing. The Binet and Simon tests are arranged to determine the mental status of children from three to fifteen years of age. If a child responds successfully to the tests arranged for its age it is probably normal so far as its intellectual development is concerned. But if it can succeed only in the tests arranged for younger children, it is backward. For example, a child of ten who could not succeed in the tests for its age, but who could successfully answer the questions in the tests arranged for a child of seven, would be three years backward in mental development. Children who are three or more years backward are looked upon as being mentally defective.

Binet has found that all children are not developed evenly. So he has determined, in estimating his results that a child has the mental development of the highest age for which it has successfully passed all the tests. Binet has also established that when the child's intellectual level has been obtained, it is to be advanced a year for every five higher tests in which it has succeeded in and two years for every ten tests successfully withstood.

A child of three should be able to comprehend spoken words and to answer simple questions by a gesture. Ask a child of three, Where are your eyes? and it should immediately point to them. A child of three should be able to repeat sentences of six syllables, but not ten. Figures, being more difficult than words because they do not convey any meaning to a child of three, are limited in the test to two, such as 6-4. When shown the pictures which Binet uses in his tests a child of three will enumerate the objects; it is not possible for him to describe any of the action in the pictures.

At four years a child should know whether it is a boy or a girl, but at three it would not be able to make the distinction. At four a child should be able to repeat three figures, be able to tell which is the longer of two parallel lines and be able to name familiar objects when they are displayed.

Among the tests at five years of age is the comparison of weights. A five-year-old child is able to tell which is the heavier of two blocks equal in size and appearance, but differing in weight. At five all children succeed in counting four. At three no child can count four, and at four only about fifty per cent of the children tested have been able to do so.

At six years a child should distinguish between morning and afternoon, should be able to define known objects and execute three simultaneous commissions. At six Binet believes that a child's esthetic perception is sufficiently developed for it to differentiate between beauty and ugliness. For this test Binet employs a picture of six heads of women in three pairs, one of which is pretty and the other ugly or actually deformed.

At seven a child should be able to count thirteen pennies; describe the pictures used in the test for three year mentalities, instead of simply enumerating the objects; point out what is lacking in unfinished pictures and name four colors.

By reason of this careful marking of each phase of the development of the human mind between the ages of three and fifteen years the Binet-Simon scale is regarded as an accurate means of measuring intelligence. But with all its advantages, Dr. Bisch has found it desirable to supplement the Binet-Simon with the Ziehen and Yerkes-Bridges methods, together with other psychological and psychiatrical procedures, in examining and classifying the atypical children admitted to the Speyer School class.

As an aid to classification Dr. Bisch has compiled the following tentative table setting forth the causes of abnormal mentality:

1. *Precocity* (*A*) congenital, (*B*) due to training.

2. *Retardation*, caused by (*A*) defective teeth, (*B*) errors of refraction, (*C*) adenoids and tonsils, (*D*) unfavorable environment, (*E*) malnutrition, (*F*) irregular school attendance (truancy, wanderlust, disease, etc.), (*G*), epilepsy, (*H*) syphilis, (*I*) tuberculosis, (*J*) sense deprivation, (*K*) gross physical handicaps, (*L*) speech defects, (*M*) neuroses and psychopathic personalities, (*N*) chorea and habit spasms, (*O*) rickets, (*P*) adolescence, etc.

3. *Arrested Development* (Resulting in Amentia), caused by (*A*) trauma, (*B*) meningitis, scarlet fever, diphtheria, etc., (*C*) epilepsy, (*D*) syphilis, (*E*) neurological condition, (*F*) adolescence.

4. *Amentia*, Idiopathic Cases (*A*) idiocy, (*B*) imbecility, (*C*) moronism (Congenital).

Special Types, (*A*) hydrocephalus, (B) microcephalus, (*C*) cretinism, (*D*) mongolism (*E*) Little's disease, (*F*) amaurotic family idiocy, etc.

5. *Moral Deviation* accompanied by (*A*) apparently normal intellectuality, (*B*) retardation, (*C*) arrested development, (*D*) congenital amentia, (*E*) adolescence, (*F*) insanity.

6. *Insanity*, (*A*) dementia praecox, (*B*) manic-depressive psychoses, etc., (*C*) episodes in constitutional inferiority, (*D*) following epilepsy, (*E*) simple dementia.

Each pupil in the class is the subject of careful individual study and observation, and his progress is recorded from day to day and filed with the record of his history, mental, physical and family, up to the day he was admitted to the class. The progress of some of the children has been more marked than others, but all have shown a decided improvement. The children are learning self government and self care, which raises them from a state of complete dependence to that of independent usefulness to a degree which would have been impossible fifty years ago.

The importance of this branch of education will become apparent when it is considered that out of the 20,000,000 school children in the United States it is estimated that 75 per cent are defective. Many of the defects from which these children suffer are minor and will yield readily to treatment. But if they are neglected the result is that the mental development of the child is inevitably retarded. A slight physical defect which can be readily eliminated by simple surgery or medical treatment will be the cause of a certain amount of strain which is bound to react on the nervous organism of the child and produce restlessness and a lack of the power of concentration. Erratic, nervous children may be brought to a normal condition through hygiene, medication, psycho-analysis or hypnotism. The tendency to extreme nervousness, if not eradicated during childhood, frequently develops into a serious mental disorder in later life. There is nothing a community can so ill afford as human waste. If the experiment in the education of defective children at the Speyer School points the way to the conservation of human beings who ordinarily would be a dead weight on society it will be of inestimable benefit to the country.

Disinfecting Railway Cars

SEVERAL years ago experiments were made in Russia in disinfecting railway cars by the use of steam and formalin, the results of which have only recently been announced. To start with the temperature inside the car is raised to 65 deg. Cent. by the admission of steam, which takes from fifteen to twenty minutes, according to the size and style of car, and the formalin is sprayed by pressure generated by an oil motor. A mixture of formalin and ammonia was also tried. The results as regards the distruction of germs of plague, typhoid, tuberculosis, etc., were fairly satisfactory, but it was found rather difficult to get a uniform temperature, and the vapors injured some of the paints used in the cars.

Selenium in the Production of Colored Glass

By Samuel Wein

SELENIUM, produced to the extent of about 11,000 pounds annually, has a very limited practical use which is mostly confined to the manufacture of red glass and red enameled ware. Ever since the patent granted to F. Welz (Ber; 25 page 819) on the process of coloring glass by means of selenium, very little has been published. It is for this reason that this paper has been written giving the actual formulæ now in use by the various glass companies both in the United States and abroad.

A great advantage in the use of selenium lies, first, in the fact that it is not necessary to reheat the glass after it has been made (which, by the way, is the usual process), and second, in the fact that its cost is much less than that of gold chloride or other chemicals used.

Welz used selenium or a compound of selenium and cadmium sulphide for the production of rose, red, and orange colored glass (*Eng. Min. Journal*, December 18th, 1897, page 731, and SCIENTIFIC AMERICAN SUPPLEMENT, January 1st, 1898, page 18,345); on investigation it was found that Welz's formula was not satisfactory.

The formula was soon corrected, and is made as follows:

Sand	100 kilogrammes
Soda	20 kilogrammes
Potash	8 kilogrammes
Lime	7 kilogrammes
Borax	0.5 kilogrammes
Cryolite	13 kilogrammes
Selenium	300 grammes
Cadmium sulphide	700 grammes
Sulphur	230 grammes

The result of the above batch is a beautiful coral-red corresponding to Kaiser-red glass.

Similarly, for a transparent yellow-red glass:

Sand	100 kilogrammes
Soda	12 kilogrammes
Potash	10 kilogrammes
Minium	20 kilogrammes
Limestone	10 kilogrammes
Selenium	200-300 grammes
Uranium oxide	60 grammes

The writer would suggest the use of selenites or selenates, as these salts are more suitable than metallic selenium, since they are more stable in the heat of the furnace, and are, in consequence, less likely to become lost through volatilization and oxidation.

Glass decolorized by means of selenium possesses an unusual clearness and brilliancy. The use of selenium as a decolorizing agent (sodium selenate is generally used) is claimed in German patents, Nos. 63,558, 75,565, and 88,615. Selenium manganese is now being marketed in the United States as a glass decolorizer.

Back Numbers of the Scientific American Supplement

WE beg to advise our readers that we have discontinued selling numbers of the SCIENTIFIC AMERICAN SUPPLEMENT dated earlier than January 1, 1914. We removed the first week in April to the Woolworth Building, New York city, and the change in our offices precluded the carrying of issues of the SUPPLEMENT extending over a period of nearly forty years. It was, therefore, necessary to turn over this portion of the business to someone who has space for carrying so large a stock. The H. W. Wilson Company of 39 Mamaroneck Avenue, White Plains, N. Y., have been chosen to take care of our back number business. They have the complete stock and are ready to supply any of the back numbers at the standard price of 10 cents. We, therefore, request that, in future, all orders for SUPPLEMENTS be sent direct to the H. W. Wilson Company instead of Munn & Co. Please do not order SUPPLEMENTS on letters ordering subscriptions for the SCIENTIFIC AMERICAN or the SCIENTIFIC AMERICAN SUPPLEMENT or books, or containing any other matters.

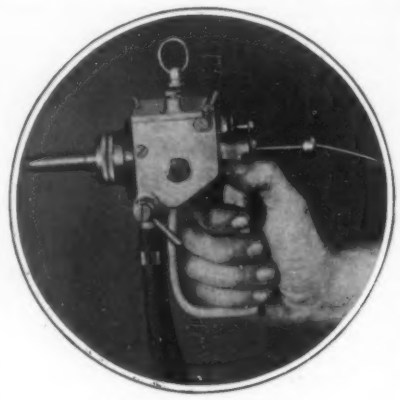
To Old Readers of the Scientific American

THE June number of the SCIENTIFIC AMERICAN will commemorate the seventieth anniversary of the house of Munn & Co. In that number we wish to give a history of the SCIENTIFIC AMERICAN. Old readers and subscribers who visited the editorial offices in the past are requested to send us their impressions, anecdotes, experiences, and the like. Indeed, any information at all relating to the old offices on Park Row will be gratefully received by the Editors.

New form spraying pistol.

Development and Perfection of Schoop Metal Spray

The Improved American "Pistol"



Old form spraying pistol.

AT a manufacturing establishment in New England there is now to be seen the operation of the spraying of metal, a phenomenon so new that the precise nature of the action is not yet understood, nor has there been stated as yet other than the merest outline of its practical possibilities. The apparatus is a development of forms already described in the SCIENTIFIC AMERICAN, and save these articles but little else has been published as yet in English.

The apparatus is an atomizer, but instead of a spray of perfume or of disinfectant drawn from a reservoir of the liquid, the reservoir here is a solid wire and the spray a shower of metal particles, which will form a coating of the metal upon any object placed a few inches from the nozzle of the atomizer. The process is the invention of M. U. Schoop, a Swiss engineer, the fundamental patents are not yet two years old, and there has been steady improvement of the apparatus in the laboratory of the inventor and in this country till it has reached the practical stage that is here to be described.

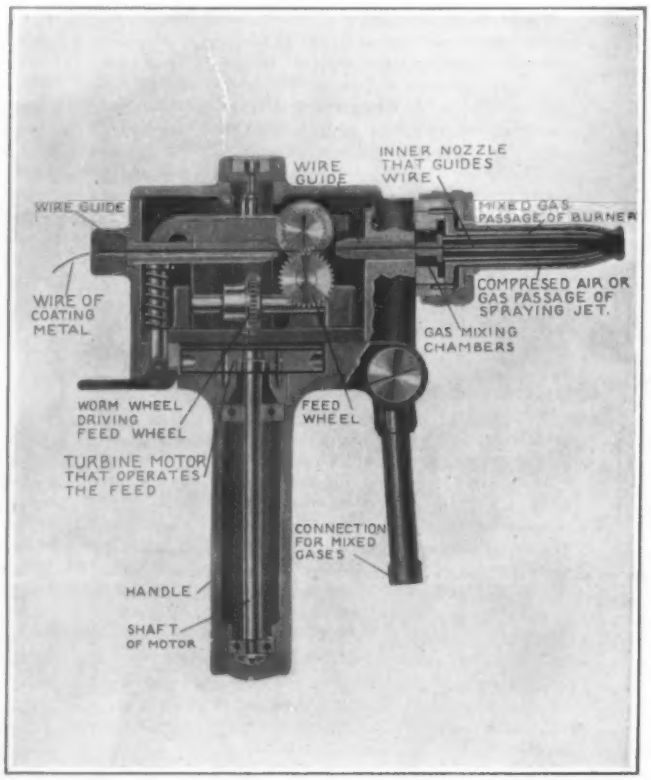
"Pistol" is a very apt name for the atomizing device. It has a grip and a muzzle, but the magazine portion is rather large relatively. The pistol is a mechanism that straightens the metal wire, feeds it a speed which may be regulated at will, concentrates upon the wire the gases that are to melt and the spray that is to atomize it, and the whole device, by means of the grip, may be directed to any portion of the object to be treated.

In its passage through the pistol the wire is physically unaltered, but on its emergence from the inner tube of the barrel the transformation takes place. It becomes a stream of metallic particles carried by a current of air or gas, just as the liquid in the atomizer becomes a similar stream of liquid drops. Interesting and curious as this transformation proves to be, it is less astonishing than the results, for just as one finds the liquid fixative in a film on the drawing, so one finds a coating of metal on the surface subjected to the Schoop metal stream. This is smooth and compacted, and if there is opportunity for it so to affix itself, its particles will be driven into the minute crevices of the object treated, permanently there to remain and cling.

Metals and alloys alike are subject to the same strange technique. Lead, tin, zinc, aluminium, copper, brass, bronze, and German silver have been tested out quantitatively, while gold and silver, though amenable to the process, have not yet furnished their full data. The film that is deposited by the spray may be from 0.001 inch upward, and is firm and continuous.

Some of the accompanying phenomena are likewise of interest. While the temperature at the apex of the cone of spray may be from 700 deg. Fahr. to 2,000 deg. Fahr., at the distance of only four or five inches, delicate materials that are combustible may be coated with the metal but will not be burned. Matches held in the spray are metalized but not ignited, tissue paper can be surfaced with metal, while brass issuing at 1,550 deg. Fahr. has been deposited on silk without injuring its texture.

It is the barrel of the pistol that is responsible for the strange results, for as has been said, the internal mechanism is devoted to straightening the wire and regulating its delivery. There are really three concentric barrels and the innermost is that through which the wire issues. The second tube conducts to the place selected for the melting point a jet of mixed gases under pressure, in fact a blow-pipe; while the outer annulus delivers compressed gas which furnishes the velocity necessary for the spray. The blow-pipe mixture may be coal gas, water gas, acetylene, hydrogen, etc., with air or oxygen for its stimulation, while the spraying jet may be carbon dioxide, nitrogen, air, steam, etc. The temperatures, pressures, and mixtures are factors to the techniques for different metals, so that accurate gages, reducing valves and the like are portions of the apparatus. Likewise the pressure and velocity of the air jet must be variable to suit the conditions required by the different metals.



Section of metal spraying pistol, showing mechanism.

Operating the metal spraying pistol.

There must be, moreover, the chance for adjustments in the barrels to accord with the diameters at which the wires are used, and relative changes are necessary in the gas and air jets. Then there must be the possibility of regulating the feed-speed of the wire, which is moved forward by a motor driven by compressed air.

So far as anyone yet can definitely analyze it, the operation is this: The blow-pipe performs its duty of melting the wire. The spraying jet has two offices: by its expansion and consequent appetite for heat it keeps the muzzle of the pistol cool; and by its velocity, which may be up to 3,000 feet a second, it entrains a stream of metal. This is in minute particles, either in the plastic state or molten. Some may perhaps be gaseous, surrounded by a protective, reducing atmosphere. This is the cone that is moving with great velocity toward the object treated.

There is this anomaly, that within four or five inches of the point of origin of the melted metal, with the consequent high temperature, delicate laces and paper, and even matches, may be placed without burning them and the hand may be held there for a moment. This is plainly a phenomenon different from that when the foundry man passes his finger through the jet of molten iron running from the furnace. In the latter case it is believed that the moisture of the skin saves it from harm, but such an explanation does not serve with the sprayed metal.

The suggestions here are that the spraying medium is enormously greater in volume than the infinitely small particles that it is carrying. It is, moreover, still expanding and seizing heat, so that, relative to the particles, the cone is cool. But, while the cone must deprive the particles of some of their heat, it seems certain from the results that they do not impact upon the object treated in the form of droplets, for if they did, they ought to rebound. For the present, the only explanation to give is that there appears to be an abnormal physical condition, and that on account of the heat of the collision the particles pass into a vapor which at once condenses on the relatively cold receiving body. There is formed on this a solid, homogeneous mass or film, hammered by the succeeding particles; altogether a curious

(Concluded on page 368.)

Measuring One Twenty-Millionth of an Inch

The Finest and Most Sensitive Measuring Instrument Known to Modern Science

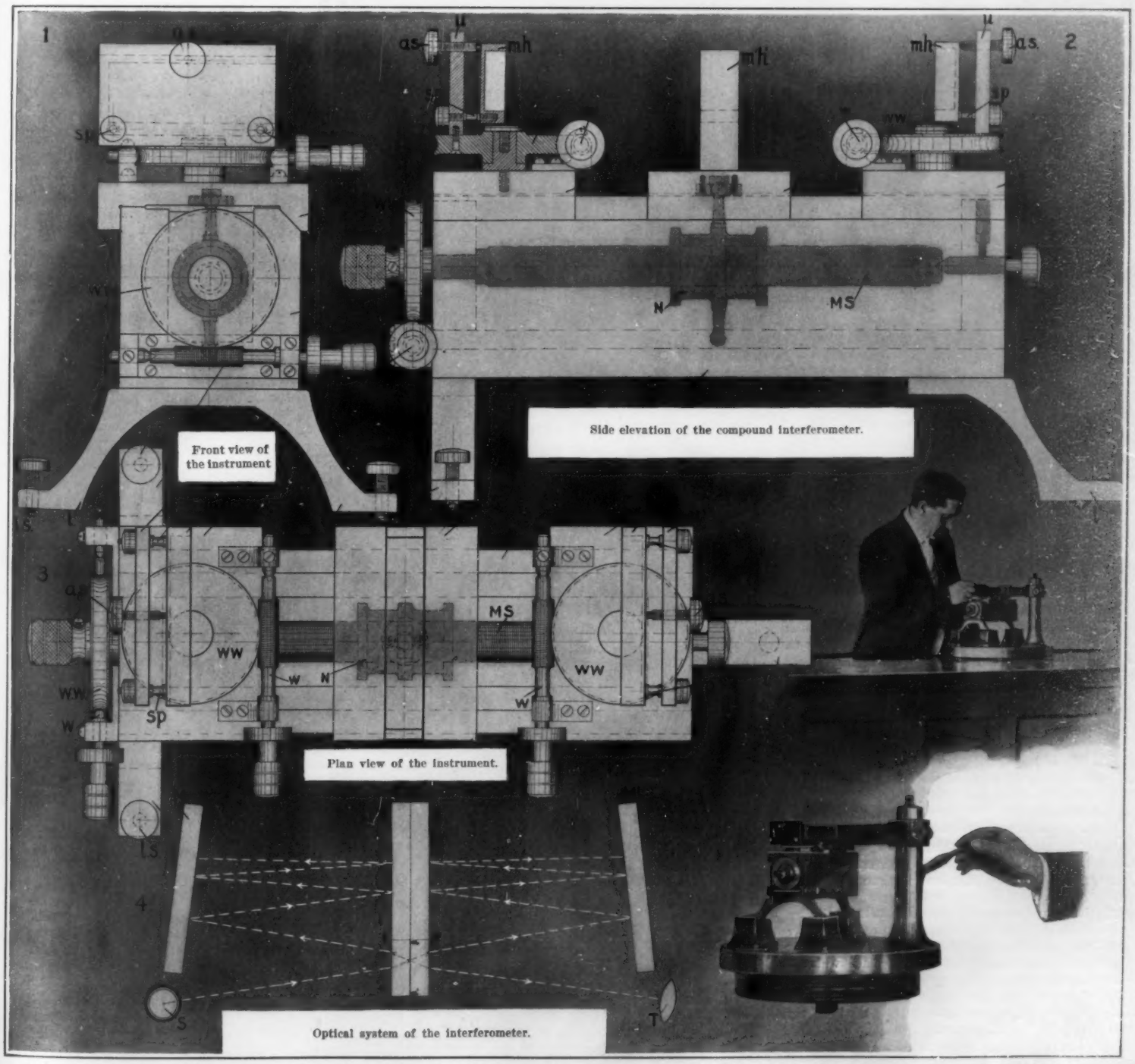
By Ernst Keil

THE inventions originated in the physical laboratories of educational institutions have contributed an immense part to the wealth of the world. The physicist relies upon the science of exact measurements to interpret the answers he receives to questions put to nature, and all the researches undertaken in physical laboratories have been made by performing measurements alone. There is not one, no matter how complicated, that in its final analysis could not be reduced to the three fundamental quantities of either *time*, *mass*, or *length*.

To carry out these measurements then necessitates the use of instruments with which to perform such measurements. In the early days of the laboratory the instruments were crude, but it did not take long to explore entirely the field within the range of those crude instruments and as necessity is the mother of invention, we find that as the need for better instruments was felt, skilled and ingenious men produced them.

The exact measurement of time has for ages received the close attention of the most skilled workers; the accurate determination of mass or weight has kept the physicist and the skilled instrument maker hard at work for many years, but the most difficult problem the physicist and astronomer had to face was the accurate determination of length or distance, whether that be along a straight line, the subdivision of a circle or the expression of an angle. To perform the most delicate and very finest measurements in determination of length, the physicist had for many years only one instrument at hand: the compound-microscope. It has played a very important part in scientific investigations, and had it not been for it many of the discoveries, the results of which we use so freely in our life to-day, would not have been possible, and yet, many problems lay beyond its range. The limitations of the microscope are adjusted by the fact that we employ light when measuring with this instrument and the waves of light are just so fine. It can be proved mathematically as well as demonstrated in a popular way that, when objects are smaller than one half wave-length of light, the microscope is absolutely unable to serve us. If we employ sunlit objects smaller than 1/80,000 of an inch they cannot be studied with it, and two objects which are closer together than 1/80,000 of an inch appear in the compound microscope as one.

The fact that the length of light-waves limited the magnifying power of the compound microscope made it again an absolute necessity for the physicist to go to work and devise an instrument that could overcome this lack of power, if physical investigation was not to stop in this direction. In due time two physicists in Cleveland, Ohio, Profs. Michelson and Morley introduced a new and most useful instrument, and they named it "*interferometer*." This new instrument consisted principally of a system of optical mirrors arranged in such a way as to let the waves of light of a suitable source pass between and through them, the waves in the course of their travel being divided and reflected a certain number of times, thus making it possible to measure objects 10 times smaller than the best compound microscope would allow us to do. This form of interferometer opened up a vast field of research investigations, and it has been used with excellent results in many physical and astronomical investigations. Unfortunately even this instrument has its limits of usefulness and there are scores of important problems awaiting investigation which lie way beyond its range. It was Prof. C. W. Chamberlain, head of the physics department of Denison University and now president of this institution, who invented the *compound interferometer*, the instrument that enabled the scientists at one stroke to measure a distance as small as 1/20,000,000 of an inch. This instrument will in all probability be the most delicate measuring instrument



Construction of the compound interferometer. One of the photographs shows Prof. Chamberlain adjusting his instrument, the other a test of the sensitiveness of the apparatus.

of its kind for many years to come. It is next to impossible for a human mind to realize the smallness of the distance measurable with this marvel of an instrument. It is an instrument 40 times as powerful as the Michelson-Morley interferometer, or 400 times as powerful as the most perfect compound microscope. We can probably form a better picture if we use some comparisons:

This 1/20,000,000 of an inch is the apparent size of the head of an ordinary pin, viewed at a distance of 227 miles; or the size of a silver dollar, viewed at a distance of 9,000 miles; or the size of a human face, viewed at a distance equal to twice the circumference of our mother earth.

Details of construction may be seen in the accompanying line-drawings. Fig. 1 shows a front view, Fig. 2 a side view, and Fig. 3 a top view of the compound interferometer. The bedplate *B* rests on three legs, *l*, *l'*, *l''*; two of the latter are provided with fine-motion leveling screws *ls*. The bedplate *B* carries on its top on suitably shaped ways the three carriages *C*, *C'*, *C''*, and the latter carry the optical system of the instrument. The mirror holder *mh* is mounted on the upright *u* by means of the two steel-posts *sp*, the latter serving as springs to be operated by the micrometer adjusting-screw *as;* the holder *mh* and the upright *u* are fastened to the worm-wheel *ww* and this in turn finally to the carriage. The worm-wheel *ww* is provided with a worm *w* to move the mirror about its horizontal plane; the micrometer-adjusting screw *as* with the two steel posts acting as springs, allows the mirror to be moved a small fraction in the vertical plane; these movements are necessary, as we soon shall see, for the adjustment of the instrument. The middle carriage *C'* carries on top nothing but the fixed mirror holder *m'h'*. Inside of the *U* shaped bedplate *B* is a fine micrometer screw *MS* with nut *N* located to transmit a linear motion to either one of the three carriages *C*, *C'*, *C''*. The head-end of the micrometer screw *MS* is provided with a worm-wheel *WW* which is operated by the worm *W* fastened to the bedplate *B*.

The accuracy of the compound interferometer depends mainly on two things:

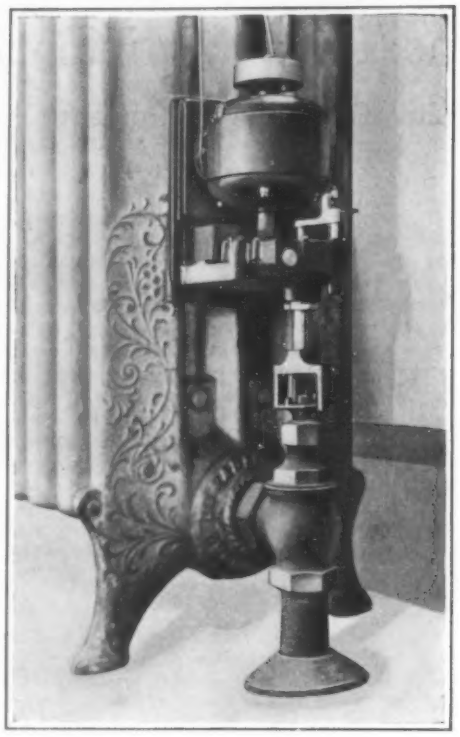
1. The parallelism and flatness of the optical mirrors.
2. The parallelism and flatness of the ways on which the three carriages, *C*, *C'*, *C''*, move along.

To make the mirrors necessary for this instrument is an art by itself. Mr. O. L. Petitdidier of Chicago made them for Prof. Chamberlain's instrument, and did it with such precision that the mirrors used were at no place more than 1/1,000,000 of an inch out of true.

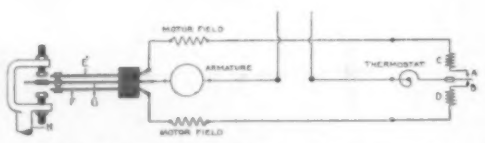
The ways the carriages travel on have to be flat, as well as parallel, to a very high degree of accuracy; the ways on the first instrument built were so accurate that, if they had been enlarged to a length of two miles, the parallelism would at the end of the two miles have varied not more than $\frac{1}{2}$ of an inch.

The optical system of the instrument shown in the diagram, Fig. 4, consists of four glasses. *M* and *M'* are the two end glasses fastened in the mirror holders *mh*. The surface of these two glasses toward the middle glass *2M* is covered with a very thin film of silver, making of them total reflecting mirrors. These two glasses have to be flat to the very highest possible degree of accuracy. The middle glass *2M* consists of two glasses of exactly the same dimensions cemented together with canada-balsam. About two thirds of the length of *2M*, 1 to 2 and 1' to 2', on the sides toward *M* and *M'*, is another fine silver film to act as a total reflecting mirror and between the two glasses from *a* to *a'* is placed a silver film of such a thickness as to split a ray of light that strikes its surface in two, letting one half of the light through and reflecting the other half; this part of the mirror is called the dividing plate. These two glasses have to be flat as well as parallel to the very highest possible degree of accuracy.

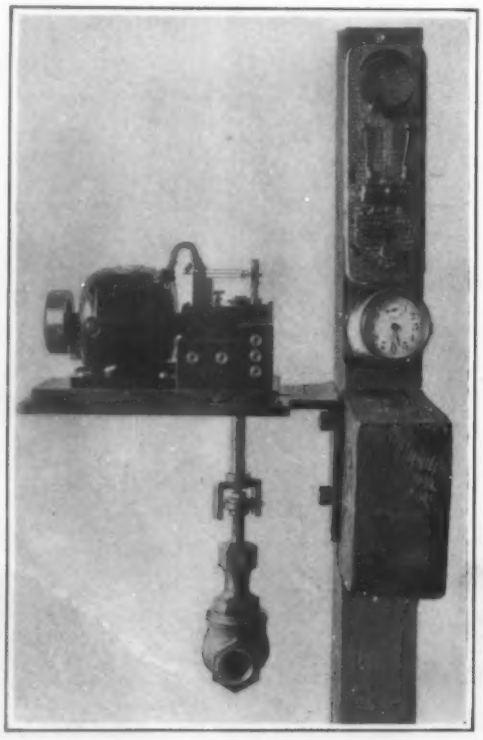
To adjust the instrument we proceed as follows: First we level our instrument by means of the leveling screws *ls;* after this we adjust the two end mirrors *M* and *M'* perpendicular to the fixed mirror *2M* by means of the micrometer-adjusting screws *as;* then we make the distance between *2M* and *M* and *2M* and *M'* as nearly alike as possible, using the worm *W* and worm-wheel *WW* for that purpose. Now we set *M* at a small angle to *2M* and *M'* at nearly the same angle, using for this movement worm and worm-wheel *w*, *ww*, respectively. The source of light, say a sodium flame, is placed at *S* (see Fig. 4). A ray of light from the source *S* enters the instrument, striking the dividing plate *a*, *a'* and being split in two equal fractions, one half of the ray passes through the dividing plate and is reflected a certain number of times between the total reflecting mirrors *2M* and *M'* until it comes to a place where it strikes *M'* perpendicular; then the ray of light travels back over exactly the same path to *a*, *a'*. The same thing, of course, happens to the other half of the ray, which is reflected from *a*, *a'* and thrown toward *M*. At *a*, *a'* the returning parts are split once more, one half going back to the source of light, the other one leaving the instrument in the direction toward *T*. At *T* a telescope is placed, through which we observe the occurrence in the instrument, and what we see is a set of yellow and black fringes—interference fringes. If the instrument happens to be adjusted to its lowest power, then the distance between two fringes represents one half wave-length of light; that is, the same sensitiveness the most perfect compound microscope possesses; but by changing the angle of *M* and *M'* in relation to *2M*, that is making this angle very small and thus forcing the light to pass oftener between *2M* and *M* and *2M* and *M'* before it strikes *M* or *M'* perpendicularly and returns over the same path (in other words, by increasing the length of the path of light by changing the angle between *2M* and *M* and *2M* and *M'*) we are able to increase the sensitiveness of the instrument forty times higher than the Michelson-Morley interferometer or four hundred times higher than the most perfect compound microscope.



Automatic electric apparatus for operating a radiator valve.



Electrical connections of the radiator controller.



Electro-thermostatic control as arranged for demonstration purposes.

One of the photographs shows an arrangement to illustrate the enormous sensitiveness of the instrument; the massive steel plate with its 2-inch post on one side is forged out of one solid block of steel and weighs about 150 pounds. This 2-inch steel post is capable of transmitting 200 horse-power. We are all familiar with the rigidity of steel, yet this instrument readily shows the bending of this heavy steel post when touched with the finger as lightly as possible. We can see what is an apparently great movement of this rigid steel post when it is delicately touched with a camel's hair brush, as shown in the picture. One will even observe a distinct movement when the breath is slightly blown against it, and when a match is dropped on this 150-pound steel plate it causes the steel post to flutter like a feather in a stiff breeze, and yet this instrument was adjusted to only one tenth of its real sensibility when these demonstrations were made.

No fewer than five different forms of compound interferometers have been designed by Prof. Chamberlain and all of these instruments were constructed in the instrument shop of the Barney Physical Laboratory at Denison University, Granville, Ohio. One of these instruments was taken abroad and demonstrated before a committee of distinguished scientists by the writer; it created there an astonishing sensation, as it did wherever it was shown. By request of the Ohio Commission a complete set of these instruments was exhibited at the Jamestown Exhibition and received the highest medal awarded to an exhibition of scientific instruments. At a meeting of the American Physical Society held in New York city, Prof. Chamberlain presented his compound interferometer with full demonstrations, thereby placing the benefits of his labor at the service of all scientific investigators.

Electro-thermostatic Control of Radiators

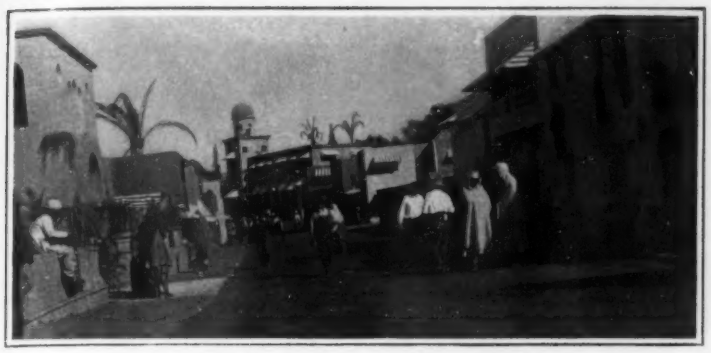
SOME time ago the SCIENTIFIC AMERICAN described an electrical starter for automobiles, using a very small motor. The motor itself was not powerful enough to turn over the engine directly, but by speeding it up sufficient energy was stored up in a flywheel to accomplish the task. Again last year the SCIENTIFIC AMERICAN described an electric brake in which the same principle was employed. Now a third application of this principle of stored energy has been brought out in connection with a thermostatic control of radiators.

There are systems now in use for operating the valves of a radiator by means of compressed air under control of thermostats. The majority of them, however, labor under the disadvantage that they involve the installation of an elaborate system of air-compressing machinery and compressed air piping which cannot be installed without considerable expense, except during the construction of a building. The idea of controlling the valve by electricity, which would simplify the installation, has not met with much favor hitherto, because it has always been supposed that a very large motor would be required to open a valve that was tightly jammed or to close it steam tight. But by the use of energy stored in a rapidly rotating flywheel, the valve may be operated with a very small motor, as has been proved by Mr. E. V. Hartford, inventor of the apparatus shown in the accompanying illustrations.

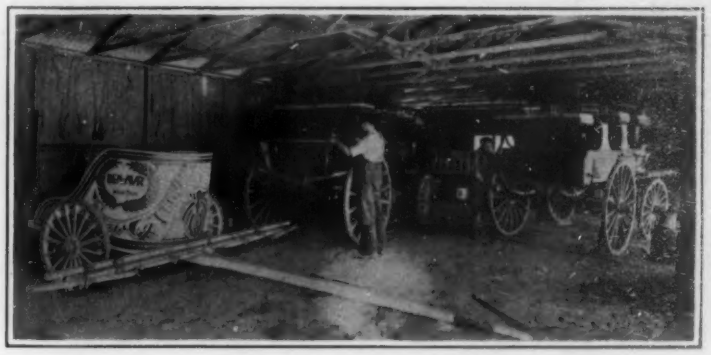
One of the photographs shows a demonstration device partly dismantled so as to disclose the details. The clock shown in the photograph is used to switch on an electric light, every so often, the heat of which actuates the thermostat and thereby causes the valve to be closed and opened. The motor used is of only 1/100 horse-power and is operated by the common 110-volt lighting circuit. This current is switched on and off directly by the thermostat without a relay, and to prevent excessive sparking a trip is used to make an absolute and effective contact at each throw of the switch. As will be observed in the illustrations, at each side of the thermostat arm there is an electromagnet, while a small disk of soft iron on the arm serves as an armature. Thus, when the arm is deflected to one side or the other, by variations in temperature, it plays between two contact points *A* and *B*. But the instant it touches one of these contact points (say *A*), the electromagnet on that side (*C*) is energized, attracting the arm and making a solid contact, admitting current to the motor. As shown in the diagram, the field of the motor is split, one half being connected with *A* and the other half with *B*, so that its direction of rotation may be reversed by changing from one contact point to the other. As soon as current is supplied to the motor, it runs up to a very high speed, and by means of a step-down gearing in the ratio of 360 to 1, it turns the radiator valve, either opening it if fed through contact *B*, or closing it if fed through contact *A*.

In order that the motor may run up to full speed, it must start with no load. Consequently it is not directly coupled to the stem of the valve. Instead, its operating shaft terminates in a fork adapted to come into contact

(Concluded on page 369.)



A scene in Tangiers staged in California.



The vehicle repair shop.

The Strangest City in the World

A Town Given Over to the Moving Picture

THERE is a wonderful city out in the heart of the San Fernando Valley, in the State of California, which is probably the most unique city in the world. Its name is Universal City, and it is the only municipality in the universe devoted to the manufacture of moving-picture films. It was officially opened on March 15th, and its population of 1,500 people are all employed in the art of making pictures. It is the make-believe city of the twentieth century, and one never knows, as he strolls about the streets of this city, whether what he sees is real or just "reel" views.

A stroll through Universal City is like going through the pages of a wonder book; a fairy tale for children. It is nothing more or less than a chameleon city, for the entire complexion and appearance of Universal City can be changed in three days to conform to any nationality, style of architecture, color scheme, or state of preservation which occasion requires. Troy, Athens, Rome, Paris, London, and New York are all distinguished and characteristic cities, but Universal City combines everything which can be found in any of these cities, and could represent all of them inside of a week, that is, for motion-picture purposes, for there is not a building in the entire limits of the city which could not be changed over night into something radically different and changed back again with equal facility.

There is no utility shop put up for the use of workmen even which could not be turned into a barracks for the quartering of soldiers, a hovel for the entertainment of thieves and desperadoes, or a ranch house for use in some western drama. The administration building itself is built with a different face on every quarter, and one of the shocks to which unsuspecting visitors at the city are likely to be subjected is the return through it from a different direction, and the realization that from that quarter every building presents a different aspect from that first seen. It is this ability to change its color at the slightest wish which makes this city the most remarkable which has ever been constructed.

As to when Universal City will be finished it is a very difficult matter to say. It has already been two years under construction, but there is no end to the possible improvements. It already has its own mayor, police, fire, street cleaning and educational departments, and, in fact, everything which can be found in the average modern city. All of the streets had to be scientifically paved and piped for gas, electricity and sewer mains. The main boulevard of the city is six miles long, and this will give an idea of the amount of work the Street Department alone has to do. The roadways of the city are peculiar in that they are of different widths and styles of top dressing, so that there will be as great a variety in this respect to choose from for scenic purposes.

The Zoo is housed in especially constructed buildings and cages, and is now the largest and finest privately owned menagerie in the world. There are African lions, leopards, tigers, wolves from the Siberian steppes, jackals, wild dogs, mountain lions, reptiles of all descriptions, from the mighty python to the hooded cobra, alligators, crocodiles, camels, dromedaries, a herd of elephants, nine different kinds of plumage birds and many others, like the American eagle and the vulture, a complete dog kennel of prize-winning thoroughbreds, all kinds of domestic animals, and a large herd of wide-horned cattle, bison, buffalo and cowponies, wild horses and gophers. These buildings have been completed and the animals have taken part in many big jungle pictures which have been seen by the public. The administration building,

An oriental street scene staged at the "Movie" city.

which houses the reception hall, meeting room, bookkeeping department, cashier's department, a suite of eight rooms for the scenario department, the library, stenographer, telephone exchange, telegraph office, auditor's and general manager's office, cost $30,000. Its façades are all different, representing different interiors and different styles of architecture. The laboratory has the same peculiarity of exterior appearance. There is also an exhibition theater, which takes on either the appearance of a city or a country theater at the behest of the director. There are barracks for housing the troops of expert cavalrymen and bunk houses for the cowboys. All of these are modern and sanitary, and can be used for many other things from the moving-picture standpoint.

One of the most picturesque spots in the city is the Indian village, which is the largest in America, and is inhabited by a tribe of redmen who are permitted to pursue their lives as they please, for they are not encouraged to adopt modern customs or costumes.

There are two restaurants as capacious and as well served as any in the city of Los Angeles, which is eight miles north of Universal City. These are for the convenience of actors who have no habitation in the city itself. The wonderful revolving stage is one of the most up-to-date features of this city, and includes many innovations and a rocking stage made especially for children's productions.

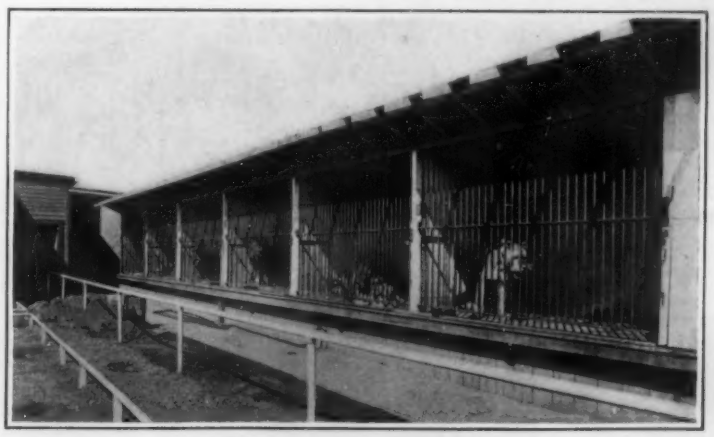
The wardrobe department contains costumes of every conceivable sort, and in addition to this are the costume shops, which can turn out the designs which are required by every period of dress, from the era of palm leaf girdles to the present time.

The five hundred dressing rooms are fireproof and are equipped with hot and cold running water, electric and gas lights, and steam heat. There are also bath rooms and swimming pools for both men and women.

There are two hospitals and infirmaries thoroughly equipped with every modern instrument for surgical and pathological remedy, and these are under the direction of two physicians, assisted by a corps of trained nurses.

Several corrals contain, among other animals, sixteen English thoroughbred saddle horses, four white Arabian steeds and one hundred and thirty-six head of Western horses, four long-horned steers, twelve burros and twelve military mules, and twelve Shetland ponies. The carriage house is equipped with some forty vehicles, ranging from the chariot of Homer's time to an up-to-date phaeton or landau; while the garage next door contains thirty cars of every description and the machinery for equipping and repairing. The blacksmithy and harness shops are all under the supervision of experts and are thoroughly equipped for the purpose intended.

For the outdoor enjoyment of the Universalites, there is a quarter-mile race-track, with concrete grandstand and stadium in the most approved university style. In this arena can be staged any kind of play calling for outdoor sports, and it is open at all times to the athletically inclined who wish to keep in trim for their arduous duties in the films. Like all other buildings in the city, this arena can be changed on short notice to represent a number of different settings. One day it may be necessary to use it for the Coliseum at Rome and another for a country fair. It can be used for an Indian durbar or a golf link.



Animal cages at Universal City.

Horse-power of a Rainfall

FEW people realize the energy in a fall of rain. On the evening of October 9th, 1914, there fell at Kansas City, Mo., in two hours 1.79 inches of rain. Assuming that this rain covered an area 4 miles square, or 16 square miles, and that it fell from an altitude of 6,000 feet, the energy represented was about 6,300,000 horse-power-hours. Were this converted into electrical energy without the usual losses it would amount to nearly 4,700,000 kilowatt-hours. At 10 cents per kilowatt-hour, this energy would cost $470,000.

A Machine that Takes Off Fat

A MACHINE that will do one's exercising for him without exertion on his part has been tried out at a Chicago hospital. Its primary purpose is to reduce weight, without requiring exercise or dieting, and repeated experiments have demonstrated its success.

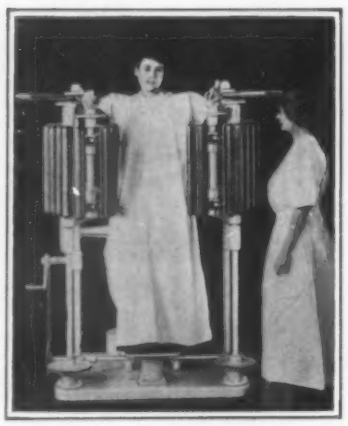
About all the patient has to do is to remove his—or rather her, since most of the patients are women—outer garments and put on something closely resembling the old-fashion mother hubbard. Then she is strapped into the apparatus. An operator touches a switch, an electric motor starts buzzing and the machine does the rest.

The machine has a platform which can be raised or lowered to any altitude desired. About half way up it has two large belts of wooden rollers, each roller being two feet long and about two inches from its neighbor. The patient stands on the platform which is raised or lowered so that the rollers will inclose him about the hips, stomach or shoulders as desired. An ingenious crankshaft arrangement makes it possible for the rollers to be adjusted closely around the circumference of the body.

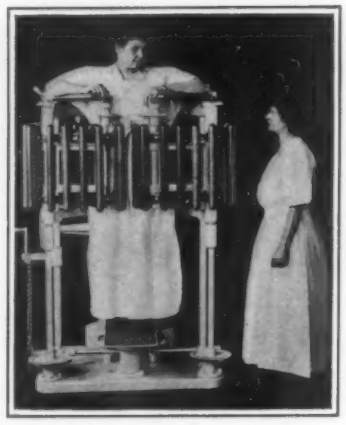
When the machine is adjusted about the patient he is held immovably in it. His arms rest upon small platforms provided for that purpose. The motor causes the belt of rollers on each side to turn, so that they will massage the body within a regular motion. The amount of pressure or speed can be adjusted according to the needs of each particular case.

It is claimed that the rollers massage the body in such a manner as to break up fat particles. At the same time the blood circulation is increased to an abnormal degree. The fat particles are dissipated, carried off by the blood and later eliminated by natural processes. Enough pressure can be obtained to give the body a rosy glow all over, clear to the finger nails, without, however, inducing perspiration or having an deleterious effect. In other words, all the physical effects of vigorous exercise can be obtained without requiring direct exertion.

The athletic department of Chicago University was the first to try it out. It was used there for the cure of "charley horse," a condition arising from bruised muscles among athletes, and its curative powers were so great that the coaches enthusiastically indorsed it. Coach Stagg of Chicago is quoted as saying his men have had no permanent "charley horses" since the machine was installed.



Patient entering the machine.



Adjusting the rollers to the body.

A machine that takes off fat.

Were the "Eoliths" Made by Man?

IN the course of his lecture, at a recent meeting of the Royal Anthropological Society, Mr. Charles Dawson, fellow of the Geological and Antiquaries Society of London exhibited many paleolithic flint implements of the early Pleistocene period, including a large fossil elephant bone sharpened to a point like a stake. This was found near the Piltdown skull.

There were also found in the gravel numerous "Eoliths"; that is, what some anthropologists think were the earliest form of implements used by man. (*Eo* = dawn — *Lithos* = a stone = *Dawn Stones* or implements.) These were supposed by some to carry the advent of the human race far back into the mists of geological ages; as to which proposition there has been much dispute.

Mr. Dawson and Dr. Smith Woodward would only admit the Piltdown skull to a modest early Pleistocene period (say 200,000 years), while Keith, Harrison, Sir Ray Lankester, Reid-Moir wanted to place man thousands, if not millions, of years earlier in the Pliocene period.

C. Dawson would not admit the "eoliths" as the work of man at all. He said these "eoliths" are merely fragments of prismatic flint a little edge-chipped by rolling in the gravel, and this had caused their present form and peculiar fractures, making them to resemble "hollow-scrapers" "borers," "planes," "rostro-carinates," and so forth.

He pointed out the resemblance of prismatic flint to starch and starch-fractures which are also prismatic, and said he had made the surprising discovery that one bag of starch contained a whole series of these eolithic implement-like forms, in miniature. It was a game anyone could play, provided he knows what an eolith is like and possesses a bag of starch.

Indeed it was only necessary after having hunted out one series, to sit on the bag to obtain a whole fresh series of "eoliths."

Copyright by Branger.

Special form of stretcher used in trenches.

Starch prisms.

Starch "eoliths."

Evidence that implements of the stone age may be natural formations.

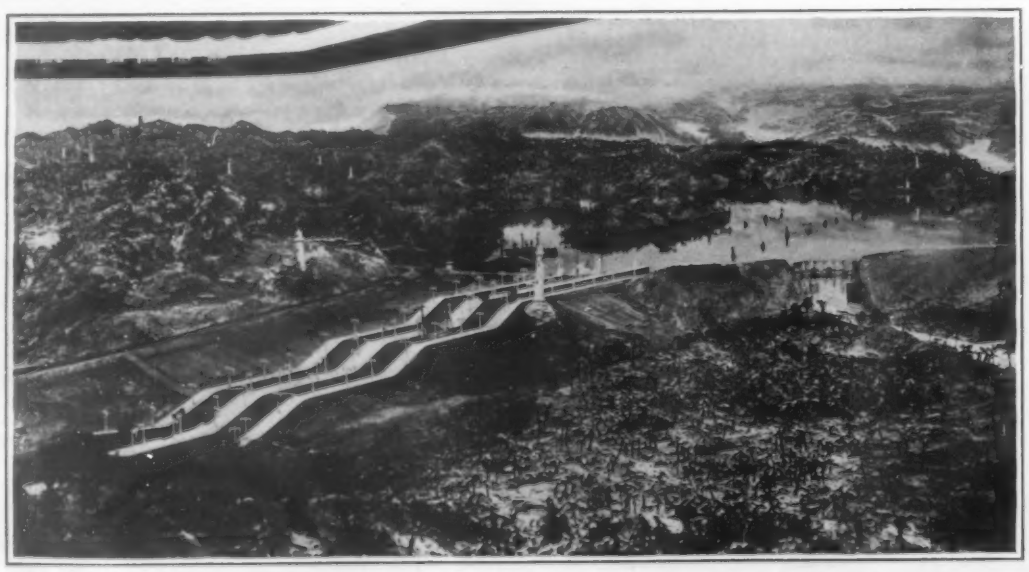
Stretcher for Trench Use

THE great European conflict has become a war of the pick and shovel, so far as operations in the western sphere are concerned; for here we find that both armies have dug themselves in and are fighting from trenches and by means of mines and countermines. This extensive trench fighting has called for a special type of stretcher which will permit of carrying the wounded through the zigzag trenches back to the field hospital. The ordinary stretcher takes too much room. As the wounded man must be carried in an outstretched position, it is difficult to convey him through the many twists and turns of the trench line. If only the wounded man could be carried in an upright position or in nearly upright position, it would be a simple matter to convey him to the rear. To permit of this the type of strecher shown in the accompanying photograph has been devised. It is really a compromise between a stretcher and a chair, being similar in shape to a steamer chair. With this type of stretcher the wounded man is carried in a reclining position which is almost a sitting posture. The stretcher has been adopted by the French army.

A Five-acre Model of the Panama Canal

THE fact that the Panama-Pacific International Exposition at San Francisco is commemorative of America's gigantic achievement, makes the reproduction of the famous waterway between the Atlantic and Pacific, as it is found on "The Zone" at the Exposition, one of the most interesting concessions along that big amusement thoroughfare.

Passing up a broad runway the visitor arrives before the longest moving platform in the world, on which seats for thousands are placed. The entrance to this platform is at the Pacific entrance to the canal, and as the spectator takes his seat a pair of disks are placed at the ears and as the journey is begun a phonographic-telephonic apparatus begins a clear and impressive lecture of the great concession, which now lies spread before the eye in the minutest detail. Each point of interest throughout the entire canal zone as reproduced at the exposition, is numbered and the phonographic lecture prefaces each description with the number at that time directly in front of the spectator. This arrangement in itself is one of the great achievements which combine to make the



Enormous model of the Panama Canal exhibited at the Panama-Pacific Exposition.

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OWING TO REMOVAL OF OUR OFFICES, we desire to dispose of two safes, one about 1½ tons, depth 2 ft. 6 inches, width 3 ft. 5 inches, height 6 ft. —the other about 5 tons, depth 3 ft. 6 inches, width 5 ft., height 7 ft. Both safes in good condition. Munn & Co., 361 Broadway, New York.

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EXPERIENCED GRINDER WANTED on Micrometer work. Steady position for first class man. State salary and give references. Address: Chiffre, P. O. Box 773, New York City.

WANTED—MONEY to perfect and patent new idea in Automobile tires, new principle, simple construction, practical. Will work on shares or loan. Box 267, New London, Conn.

WANTED—PARTIES TO FINANCE patented automobile and stationary kerosene engine that reduces weight, cost and fuel consumption to half that of modern engines. Wonderful merit. The Conners Development Co., 1316 Peoples Gas Bldg., Chicago.

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GENERAL MANAGER
P. O. Box 177 Cleveland, Ohio

canal concession a wonderfully interesting one, and the fact that the platform journey consumes over half an hour shows on what a stupendous scale the whole exhibit has been arranged.

The moving platform, operated by electricity, is nearly a mile in length or would be were it placed in a straight line instead of traveling a circular course. As the Pacific entrance is passed, tiny boats operated by magnets placed under the surface of the water, enter and leave the locks, while speeding trains, brilliantly illuminated, can be seen rushing over the rails of the Panama Railroad. At night the canal is illumined with the red and white buoys which mark the channel. Big wireless towers discharge their messages into the air from various parts of the canal right of way and the scene is one of great interest and activity. The model was constructed at a cost of $300,000.

Raising the "F-4"

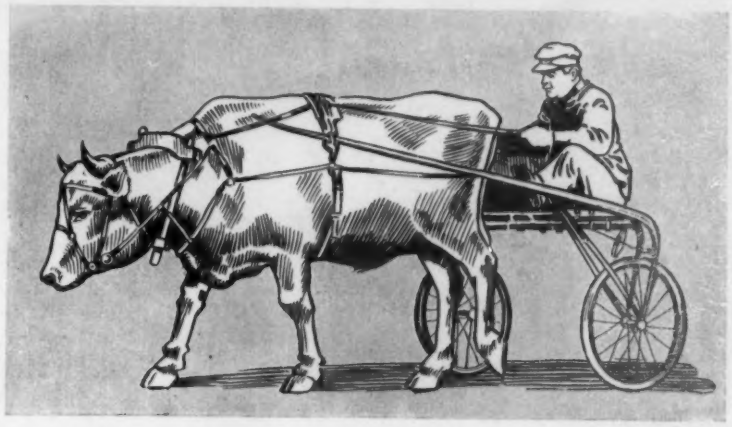
(Concluded from page 355.)

ter is perhaps the more difficult matter. A gradual deterioration of the air one breathes is apt to escape attention for awhile. And yet it is the oxygen supply that enables the diver to perform his work. To distinguish between the effects of his own muscular exertions and those resulting from a devitalization of the air would seem to be something requiring cool judgment and experience.

Perhaps the most notable advance in connection with the development of deep diving is the utilization in training of artificial means of reproducing deep water conditions. It is by this method that Gunner Stillson's party has been brought to a high state of efficiency. It was such training that prepared Chief Gunner's Mate Drellishak for the accomplishment of his record-breaking feat.

One of the manufacturers of diving apparatus has installed at their works in Brooklyn a large pressure tank. This tank consists of a steel shell in the form of a vertical cylinder in which the contained water may be put under any pressure desired up to one corresponding to a depth of 250 feet or more. Drellishak and companions, one at a time, experienced in this tank pressures up to 110 pounds per square inch. The pressure is applied by means of an air cap covering the surface of the water. The tank is 7 feet in diameter and contains under normal conditions perhaps 8 feet of water. At four points in circuit there are glass windows 1 inch thick, which permit observations from the outside. The interior is lighted by electricity. It was found necessary, however, to filter the Brooklyn water in order to make the lighting effective. The diver puts on his diving suit as if he were going down in open water and descends into the tank. The cover is secured in place and compressed air turned on both for the tank and for the diver. In this way, precisely the same pressure conditions may be reproduced as would exist in a real case of diving. By increasing the pressures, the conditions at any desired depth within the pressure capacity of the apparatus may be reproduced. The advantage of the tank lies in the large fact that with it a diver may be closely watched when learning and any defects in his equipment or his mental reactions learned. Mistakes are not so dangerous with such a tank. This promotes confidence and makes possible the practical development of man and apparatus.

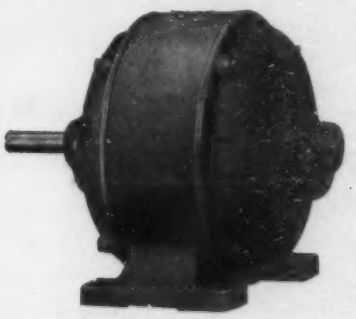
The type of equipment to be used by the American navy divers at Honolulu is, in the main, that used by the British navy. There is the helmet, the breastplate, the air-pipe, the telephone, and the life-line. At Honolulu, the air will probably be supplied by a power compressor located on an attendant vessel, and not by the hand-worked pump usually employed in diving operations. The diving procedures that are to take place in connection with the raising of the "F-4" differ from others not so much in the mechanical appliances as in the thorough-going preparation of the men for deep work. It has been found desirable to have a de-



All the Power of the Strongest Ox Won't Win a Road Race. Neither Will a Race Horse Pull a Dray

THE electric motor for a vacuum cleaner or a light lathe should be built for speed rather than great power. For a coffee grinder or a meat-chopper you need another type—one with greater power for starting and speed for continuing.

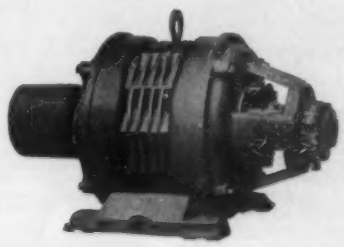
Westinghouse Electric Small Motors, above all others, are especially designed for each of the several classes of small motor service.



Type C. A.—$\frac{1}{20}$ to 1 horse power.

The three types of small single phase motors built by the Westinghouse Company are most economical of power. Every requirement is met by a large variety of sizes.

A separate corps of Westinghouse engineers devotes its entire time to small motor design and application problems. One entire building is devoted to the manufacture of Westinghouse Electric small motors.



Type A. R.—½ to 10 horse power.

Satisfaction in a small motor for any service comes only from having the proper motor in the proper place.

The way to order is to describe the service to our engineers and let them advise the type that will fit the case. There is no charge for the aid of this department. We carry extensive stocks in principal cities.

We invite your correspondence and will be glad to send descriptive matter on any type of motor. Address Dept. E-J.

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The Agency of a United People

A striking comparison between a homogeneous country and a heterogeneous group of countries is obtained by placing over the map of the United States the map of Europe. These represent the same area—about 3,000,000 square miles—if a few of the remote provinces of Russia are omitted.

Europe has the advantage in population, with more than four times as many people as the United States; in the number of large cities, with two and a half times as many cities of over 100,000 population.

Yet the United States, a comparatively young country, has outstripped Europe in the diffusion of civilization, because of its wonderfully greater means of communication between all parts of its area. The United States not only excels in transportation facilities, but it has nearly three times as many telephones as Europe, or about eleven times as many in relation to population.

By the completion of the Transcontinental Line we now talk from one end of this country to the other, while in Europe the longest conversation is no farther than from New York to Atlanta, and even that depends on the imperfect co-operation of unrelated systems.

Europe, with twenty-five countries and many different languages, serves as an illuminating contrast to the United States, with one language and a homogeneous people, despite the fact that our population has been derived from all parts of the world.

During the last forty years the steadily extending lines of the Bell System have contributed in no small measure to this amalgamating of different races.

The latest achievement—the linking of coast to coast—has given greater force to the national motto, "E Pluribus Unum."

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
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One Policy *One System* *Universal Service*

compression chamber. This consists of a big tank, resembling a horizontal boiler, in which a diver who has come to the surface too rapidly may be placed and subjected to the air pressure deemed desirable for promoting his recovery. The pressure may be reduced as slowly or as rapidly as necessary.

Development and Perfection of Schoop Metal Spray

(Concluded from page 362.)

mixture of cold working and rapid liquefaction and solidification.

The need of methods whereby one metal can be coated with another has always been felt. It has led in the past to the various processes of hand-plating and the absolutely necessary electro-plating. The latter has its limitations for universal application, one of these being the size of the baths, and another, the fact that the acids employed corrode and injure some of the metals that one would like to treat. Then there has been inability to deposit in such ways the commoner protective metals like lead and aluminium, the latter never having been amenable heretofore to coating processes. It may thus be seen that there is a wide field in larger industrial protective processes.

The electrical fusion of copper dust on non-conducting surfaces is a process employed for coatings of metal, but this is as a decoration and at a price that is practically prohibitive for a protection. There are also processes of dry galvanizing, Sherardizing, etc., but these are comparatively expensive, or lack flexibility, and some of them are merely temporary. The processes have thus been restricted in the choice of coatings and imply temperatures or chemicals or unaccommodating apparatus. On account of limitations of the kind there has been no better preservative for engineering works exposed to weather or other chemical action than painting or using enamel, with the results that are familiar to everyone.

The principle of the spray has already been described and illustrated in earlier accounts in the SCIENTIFIC AMERICAN. The first suggestion and the first trials along the line of the present success were with molten metal. A jet of air or gas moving with velocity lifted the liquid metal from a reservoir prescisely as the jet from a common atomizer lifts the disinfectant from the bottle. There were mechanical and economic difficulties involved in this. On the one hand there were the problems of attaining and maintaining the high temperature necessary to the molten metal, and on the other hand the necessity of melting perhaps a ton of metal when a few pounds only were to be used. The apparatus was cumbersome and the process was confined to metals and alloys of low melting point. One of the difficulties was the cooling effect of the spray—an expanding gas—and unevenness characterized the results. With tin and lead a moderate measure of success was attained.

Next Mr. Schoop tried the application of powders artificially produced. Such dust, acted upon by gaseous jets and with heat and pressure, has been impacted upon a base with some success. The form of apparatus termed "Cyclone" is in use, but it deals entirely with zinc. Other metallic powders prove to be rapidly oxidized.

The third step in this interesting evolution was the pistol, and evolution is an appropriate word, for from an original of a ton or more in weight it has been improved down to its present form, a compact, convenient hand instrument of 3½ pounds.

The pistol itself has been subject to improvement, its earliest form having its motor driven by the compressed air which afterward was used for the spraying jet. A second form located the motor in the top of the pistol, with its power through a by-pass and exhausting into the air, the jet being produced by its own supply of compressed air. This pistol is a cubical box of about 3½ inches to the side and is still in use. An improvement developed in this country, and now being set up, re-

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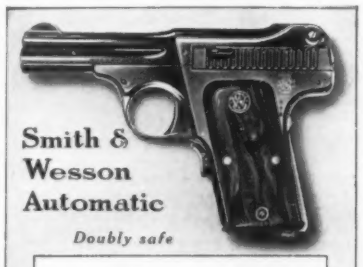
5 Factories : : : : 11 Branches



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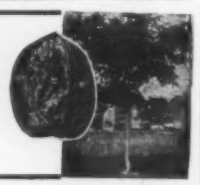

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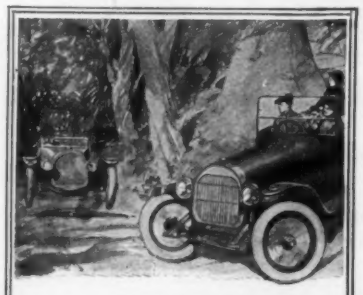

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But fool-driving is one of the hazards of motoring—a terrible hazard at a spot like this.

How do you know your brake lining will hold in an emergency? You cannot tell by looking at the outside of the brakes. It's the *brake lining* that stops the car. Brake lining is the frictional substance between brake drum and brake band. If it is an inferior quality it quickly wears out—gets hard and dry—loses its friction and the brakes fail to hold the car.

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places the brass box with an aluminium cylinder. The grip is centrally below the cylinder, giving greater ease of control and better balance, the most awkward factor, the tube for compressed air, entering conveniently through the grip. The tubes of the gases for combustion are attached to the muzzle, where they communicate directly with the mixing chamber.

The motor is now located in the bottom of the pistol with a long shaft running to a bearing in the lower end of the grip, insuring stability, smoothness of running, and opportunity for long-lasting lubrication. These features are desirable for the motor runs with a speed of about 25,000 turns a minute. It is the intention to place the motor while the pistol is in the factory, to which it may be returned for repairs. The feed mechanism for the wire is to be mounted on projections cast on the cover of the motor well, making a single group that can be withdrawn for inspection, and a cover closes the pistol on the top.

In the advance publication on the subject in the Institute of Metals, Morcom presents the following table:

DATA FOR SPRAYING VARIOUS METALS.

Metal.	Diameter of wire used. Millimeters.	Rate of feed. Grammes, per second.	Gas used per minute in cu. ft.			
			Hydrogen—Oxygen.		Coal Gas—Oxygen.	
Aluminium	1.0	9.5	1.5	0.5	0.7	0.6
Brass	0.8	17.0	1.5	0.5	0.8	0.65
Bronze	0.8	17.0	1.5	0.5	0.8	0.65
Copper	0.8	14.0	1.8	0.6	*	*
Cupro-Nickel	0.8	12.0	1.8	0.6	*	*
Gold	0.8	45.0	1.5	0.5	*	*
Iron	0.8	8.0	2.0	0.7	*	*
Lead	3.0	300.0	1.0	0.35	0.45	0.4
Nickel	0.8	9.0	2.0	0.7	*	*
Silver	0.8	18.0	1.5	0.5	*	*
Tin	2.0	200.0	0.8	0.3	0.35	0.3
Zinc	1.0	45.0	1.2	0.45	0.55	0.5

*Indicates that the experiments are not completed.

It has been proven by experiment that there is a definite efficiency point with each form of pistol, and with a given form there is nothing to be gained by increasing pressures. The general ratio is 1.5 feet of hydrogen to 0.5 foot of oxygen, or 0.8 foot of coal gas to 0.65 foot of oxygen. It is true, however, that for the refractory metals a little may be gained by forcing, but for the others the figures given are the maximum.

The costs of the process are not prohibitive even for the finer metals, while for lead it is figured to be between one and two cents a square foot, and one pound of the metal may be sprayed in a minute.

It is still too early to indicate, save in the most general way, the possible applications for a process that will coat with a metal film almost any desired surface, although, in fact, it is in daily use in manufacturing establishments in the country. Attention was called to it in France as a means of renewing lead linings in drums used in acid processes, while the Northern Railway Company experimented on its suitability for metal coating the bases of telegraph poles.

The obvious broad use of it is to preserve from decay in the atmosphere, or through moisture or chemical action, the surface of any coherent substance, including wood, paper, *papier maché*, stone, cement, and the like. Then it will preserve the vulnerable metals like iron steel in every variety of their uses. It is applicable to the treatment of any portion of an object and different sections of the same surface may receive coatings of different metals. It may be used for plating in its usual sense, where a dense continuous surface is required, and is applicable to other processes where porosity as well as permanence is desired. It is further available for fine replicas which may be made in detachable shells, and in electrical resistance and conduction lie other important fields of use.

Electro-thermostatic Control of Radiators

(*Concluded from page 364.*)

with a pair of lugs projecting from a disk

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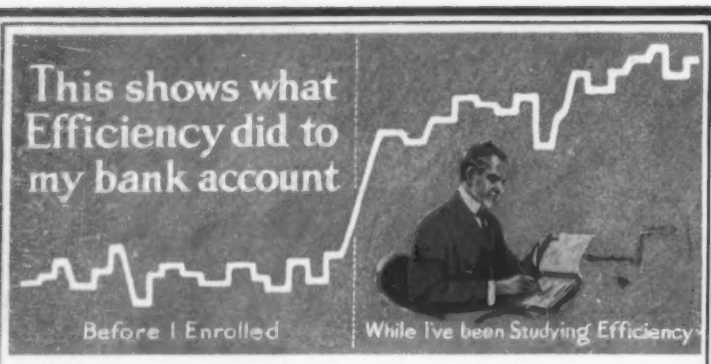

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on the end of the valve stem and shown clearly in the photographs. There is enough play in this coupling before the fork comes into contact with the lugs to permit the motor to run up to full speed, when it has built up enough energy to start a valve that would be difficult to turn by hand.

In order to cut the supply of current to the motor in time and yet provide an absolute seal of the valve, the controller shown at the left hand end of the diagram is used. Here it will be seen that there are three contact strips, *E* connecting one field motor, *F* with the other field motor, and *G* with the armature. Contact *G* has an extension that projects between a pair of adjusting screws on the controlling arm *H*. The arm *H* is geared to move up or down slowly as the valve is opened or closed. Normally, the spring contacts *E*, *G*, and *F* are in contact, but just before the valve is closed the arm *H* will have been moved down enough to depress the spring *G*, breaking the contact with the spring *E* and thus opening the circuit of the motor, but owing to the momentum of the latter the valve will continue to move down until firmly closed upon the valve seat. On the other hand, when the valve is being opened the lower adjusting screw of the controller *H* will lift the spring *G* out of contact with the spring *F*, cutting off the current just before the valve is fully opened, and depending upon its momentum to complete the operation. The point at which the current is cut off, either when opening or closing the valve, depends upon the positions of the adjusting screws and the gap between them.

The economy of this system should be very marked. The temperature in a room does not ordinarily vary so much as to require frequent operation of the motor, and then the amount of current it consumes is practically negligible.

An Important Moving-picture Decision

A DECISION has just been handed down by Judge Mayer of the United States District Court for the Southern District of New York sustaining two patents of Nicholas Power, covering certain features of motion-picture projection apparatus.

The patents in suit are No. 826,112, dated July 17th, 1906, directed to the framing mechanism of a projection machine, and No. 959,601, dated May 31st, 1910, covering the fireproof magazine and the fire extinguishing valve to prevent the entrance of the flame of a burning film into the magazine.

In regard to the framing mechanism patent, Judge Mayer says in part:

"Others were striving for a result, but Power attained it, and to-day his machine concededly dominates the market and its sales are remarkable. . . .

"Business ability, finely constructed machine parts, and a good selling organization cannot accomplish such a result without a basically satisfactory product. We are not dealing with some pleasing article which, for the time being, catches the public, but with a delicate mechanism which, to succeed, must consistently make good with the exhibitor and the audience.

"I am fully convinced that the patent is meritorious and should be sustained."

Concerning the fire valve patent, the opinion of the Court includes the following:

"We all know that motion-picture exhibitions are attended daily by many thousands of people and we all appreciate the danger which would result not only from fire, but more seriously, perhaps, from panic.

"Thus, any instrument of fire protection becomes important which shall instantaneously extinguish fire and be so constructed and adjusted as not to scratch nor impair the film. . . .

"What the art needed from an efficient and commercial standpoint was a fire protection device which would also protect the film. It must be remembered that the film travels at the rate of about sixteen pictures per second, that splices are not unusual, and that scratching either destroys or impairs the film to the extent of seriously deteriorating the picture which is thrown on the screen. . . .

"In my opinion, it required a faculty more than ordinarily to be expected from the man skilled in the art to produce the Power valve. . . . Indeed, the prior art in respect of this device which now looks so simple but which was unattained by others, is, to my mind, convincing proof that what Power accomplished in this regard was invention."

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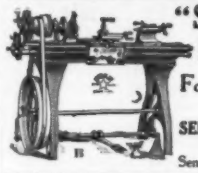

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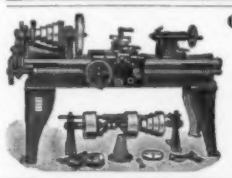

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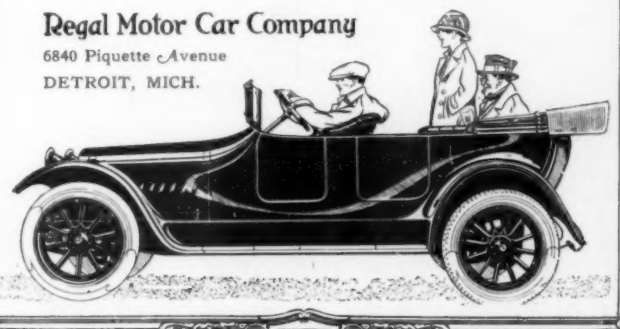

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	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter
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Alco	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	.	.	.	.
Americas	A	Arc.	A	Arc.	A	Arc.	A	Arc.	.	.
Apperson	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Auburn (4 cyl)	A	A	A	A	A	A	A	A	A	Arc.
" (6 cyl)	.	.	.	.	.	.	Arc.	Arc.	Arc.	Arc.
Autocar (2 cyl.)	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" (4 cyl.)	A	Arc.	A	Arc.	.	.	.	.	.	.
Avery	A	E	A	A	A	A	A	A	A	A
" (Model C) 1 Ton	.	.	.	.	.	.	Arc.	Arc.	Arc.	Arc.
Buick	A	Arc.	A	Arc.	A	Arc.	A	Arc.	Arc.	Arc.
Cadillac	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	.	.
" (8 cyl)	.	.	.	.	.	.	.	.	Arc.	Arc.
Cartercar	A	E	A	E	A	E	Arc.	Arc.	Arc.	Arc.
" Com'l.	A	Arc.	A	Arc.	A	Arc.	.	.	.	.
Case	A	A	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Chalmers	A	Arc.	Arc.	Arc.	Arc.	Arc.	A	A	Arc.	Arc.
Chandler	.	.	.	.	.	.	Arc.	Arc.	Arc.	Arc.
Chase (air)	B	B	B	B	B	B	B	B	B	B
" (water)	.	.	.	.	.	.	Arc.	Arc.	Arc.	Arc.
Chesterfield six	.	.	.	.	.	.	.	.	A	Arc.
Chevrolet	.	.	.	.	A	A	A	Arc.	Arc.	Arc.
Cole	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Cunningham	A	A	A	A	A	A	Arc.	Arc.	Arc.	Arc.
Delaunay-Belleville	B	A	B	A	B	A	B	A	.	.
Detroiter	.	.	A	Arc.	A	Arc.	A	A	A	Arc.
" (8 cyl)	.	.	.	.	.	.	.	.	Arc.	Arc.
Dodge	.	.	.	.	.	.	.	.	E	E
E. M. F.	Arc.	Arc.	Arc.	Arc.	.	.	.	.	.	.
Empire	A	Arc.	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Fiat	B	A	A	A	B	A	B	A	B	A
Flanders	E	E	Arc.	Arc.	.	.	.	.	.	.
" (6 cyl.)	.	.	.	.	Arc.	Arc.	.	.	.	.
Ford	E	E	E	E	E	E	E	E	E	E
Franklin	A	Arc.	A	Arc.	A	Arc.	A	A	A	A
" Com'l.	B	A	A	Arc.	A	Arc.	.	.	.	.
Garford	A	E	Arc.	Arc.	Arc.	Arc.	.	.	.	.
" Com'l.	A	Arc.	Arc.	Arc.	Arc.	Arc.	A	A	.	.
Grant	.	.	.	.	.	.	Arc.	Arc.	Arc.	Arc.
Havers	A	Arc.	A	Arc.	A	Arc.	A	A	.	.
" (Model 6-60)	.	.	.	.	.	.	Arc.	Arc.	.	.
Haynes	A	A	Arc.	A	Arc.	A	Arc.	A	A	Arc.
Hudson	A	Arc.	A	Arc.	A	Arc.	Arc.	Arc.	Arc.	Arc.
Hupmobile	.	.	.	.	A	Arc.	A	Arc.	A	Arc.
" (Model 20)	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	.	.	.	.
I. H. C. (air)	.	.	.	.	B	A	B	A	B	A
" (water)	.	.	.	.	A	A	A	A	A	A
International	B	B	B	A	.	.	.	.	.	.
Interstate	A	Arc.	A	Arc.	A	Arc.	.	.	.	.
Jackson	A	Arc.	A	Arc.	A	Arc.	Arc.	Arc.	Arc.	Arc.
Jeffery	.	.	.	.	.	.	A	A	Arc.	Arc.
Kelly Springfield	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	A	A	A	A
King	A	B	A	E	A	E	A	A	A	Arc.
" (8 cyl)	.	.	.	.	.	.	.	.	Arc.	Arc.
Kissel Kar	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" " Com'l.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	A	Arc.	A	Arc.
" " (Model 48)	.	.	.	.	.	.	A	A	A	A
Klink Kar	Arc.	Arc.	Arc.	Arc.	Arc.	A	Arc.	A	Arc.	A
Knox	B	A	B	A	B	A	B	A	B	A
Krit	A	A	A	A	A	A	A	A	Arc.	.
Lippard Stewart	.	.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Locomobile	Arc.	Arc.	Arc.	Arc.	Arc.	E	E	E	E	.
Lozier	Arc.	Arc.	Arc.	Arc.	Arc.	A	Arc.	.	.	.
Lyons Knight	.	.	.	.	.	.	B	B	A	A
Mack	A	E	E	E	E	A	E	A	E	E
" (Model S)	.	.	.	.	A	A	A	A	A	A
Marion	A	E	A	Arc.	A	Arc.	Arc.	Arc.	Arc.	Arc.
Marmon	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Maxwell	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Mercer	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" (22-70 Series)	.	.	.	.	.	.	.	.	Arc.	Arc.
Metz	B	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Mitchell	A	Arc.	A	Arc.	A	Arc.	A	A	A	Arc.
Moline	A	Arc.	A	Arc.	A	Arc.	.	.	.	.
" Knight	.	.	.	.	.	.	A	A	A	A
Moon (4 cyl.)	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	A	Arc.	Arc.	Arc.
" (6 cyl.)	.	.	.	.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
National	A	A	A	A	A	A	A	A	A	Arc.
Oakland	A	Arc.	A	Arc.	A	Arc.	Arc.	Arc.	Arc.	Arc.
Oldsmobile	A	Arc.	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Overland	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Packard	Arc.	Arc.	Arc.	Arc.	Arc.	A	Arc.	A	A	Arc.
Paige	A	Arc.	A	E	A	E	A	A	A	Arc.
" (6 cyl)	.	.	.	.	.	.	.	.	Arc.	Arc.
Pathfinder	.	.	.	.	A	Arc.	Arc.	Arc.	Arc.	Arc.
Peerless	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Pierce Arrow	A	Arc.	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
" " Com'l.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Pope Hartford	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	.	.
Premier	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
Rambler	A	Arc.	Arc.	Arc.	Arc.	Arc.	.	.	.	.
Regal	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Renault	A	Arc.	A	Arc.	A	Arc.	A	Arc.	.	.
Reo	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
S. G. V.	B	Arc.	B	Arc.	B	Arc.	A	Arc.	A	Arc.
Saurer	A	Arc.	A	Arc.	A	Arc.	Arc.	Arc.	Arc.	Arc.
Saxon	.	.	.	.	.	.	E	E	E	E
Selden	A	E	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Simplex	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Speedwell	A	Arc.	A	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
" Mead	.	.	.	.	A	Arc.	B	A	B	A
Stearns	A	Arc.	A	Arc.	.	.	.	.	.	.
" Knight	.	.	A	A	A	A	B	A	B	A
" (Light 4)	.	.	.	.	.	.	.	.	A	Arc.
Stevens Duryea	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Stoddard-Dayton	A	A	A	A	A	.	.	.	.	.
" Knight	.	.	A	A	A	.	.	.	.	.
Studebaker	A	Arc.	Arc.	Arc.	A	Arc.	A	Arc.	Arc.	Arc.
Stutz	.	.	Arc.	Arc.	Arc.	A	A	A	A	A
Velie (4 cyl.)	A	Arc.	A	Arc.	A	Arc.	A	Arc.	A	Arc.
" (6 cyl.)	.	.	.	.	.	Arc.	Arc.	Arc.	Arc.	Arc.
Waiter	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	A	A
White	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.
Willys Knight	.	.	.	.	.	.	A	B	A	.
" Utility	.	.	.	.	.	.	A	Arc.	Arc.	Arc.
Winton	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.	Arc.

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